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ABSTRACT

Fishing is one of the oldest and most popular outdoor activities. Like most activities, fishing requires basic knowledge and skill for success. The Aquatic Resources Education Curriculum is designed to assist beginning anglers in learning the basic concepts of how, when, and where to fish as well as what tackle to use. The manual is designed to be used in beginning sport fishing classes. It is intended to be an independent, self contained curriculum and incorporates lesson plans, background texts, and lists of other resources including state and federal agencies, tackle companies and conservation organizations. The manual is divided into four major units of study including: (1) a fishing primer; (2) becoming a better angler; (3) understanding fish and their environment; and (4) water resources for our future. These units have been subdivided into 28 individual lessons. There is an additional lesson on careers at the end. Appendices include a glossary, bibliography, sources of additional information or assistance, sources of fishing tackle, equipment, free and/or inexpensive materials, and graphics to supplement the lessons. Each lesson plan contains objectives, a list of needed materials, an outline of the lesson content and suggested classroom procedures. (CW)

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EDUCATION CURRICULU

SE 048 853

Aquatic Resources Education Curriculum

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Preface

FISHING INSTRUCTOR'S GUIDE

In 1984 a representative of the Bass Anglers Sportsman Society (B.A.S.S.) and personnel of the Fish and Wildlife Service jointly proposed that an Aquatic Resources Education Council be established as a mechanism to encourage implementation of the aquatic education features of the Wallop-Breaux Act. They proposed that a Council be established and sponsored by the International Association of Fish and Wildlife Agencies.

The first meeting of an interim Council was held March 4, 1985, in Washington, D.C., at which time it was the consensus that an instructor's guide should be the Council's first project to fulfill the educational requirements of the Wallop-Breaux legislation. Later that same March the Association authorized the formal establishment of the Aquatic Resources Education Council to serve as a forum for bringing together those organizations, agencies and individuals having an interest in or a responsibility for aquatic education.

Since that time, the American Fishing Tackle Manufacturers Association has been the principal financial sponsor of the work under the professional direction of Dr. Louis Jensen of Indiana State University. Authors C. Boyd Pfeiffer and Mark Sosin were contracted to do the actual writing. A major chore of the Council was the development of an outline and agreement upon a balanced curriculum for the proposed guidebook. As the writing began and progressed, review responsibilities were assigned to make certain that the finished product would be technically accurate. The sections relating to fishery biology were assigned to the American Fisheries Society, namely Dr. John Nickum; the fishing tackle segments were reviewed by the professional staff of the Sport Fishing Institute, but principally Steve Moyer; and the boating portions were reviewed by the National Association of State Boating Law Administrators, mainly by George Stewart. Review copies of the corrected manuscript were circulated to all members of the Council for final review and comment.

From the outset it was determined to prepare the guide in such a way so that individual chapters or segments could be utilized if the entire guide was not necessary to the user's needs.

At its March 4, 1987, meeting in Washington, D.C., the agencies and organizations represented on the Council lent their general endorsement to the completed manuscript and recommended that publication proceed. The first major undertaking of the Aquatic Resources Education Council had been successfully accomplished. Use of the guide qualifies for funding under the Wallop-Breaux program.

Publication represents a significant advance in putting forth the elements of a sound aquatic education for the guidance of those who administer Wallop-Breaux programs.

Jack Berryman, Executive Vice President
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How to Use This Manual

INTRODUCTION

Fishing is one of the oldest and most popular outdoor activities, with approximately 60 million Americans participating. Like most activities, fishing requires basic knowledge and skill for consistent success. Some beginners have experienced friends or relatives to teach them how to fish. Others are not as fortunate. The Aquatic Resources Curriculum has been designed to assist beginning anglers in learning the basic concepts of how, when, and where to fish as well as what tackle to use while fishing.

The goals of the Curriculum, however, are much broader than teaching basic fishing skills and a knowledge of fishing equipment. Fish biology and behavior, reproduction and growth, fish senses, aquatic communities and food chains, water, management and conservation, and fishing ethics and personal commitment to the outdoors are all major areas of discussion and study. The perceptions of nature and the outdoor environment the students gain as they participate in this aquatic education program will provide a framework for them to develop a personal philosophy of the human relationship with, and their personal role in, perpetuating the aquatic environment for future generations.

THE INSTRUCTOR MANUAL

The manual is designed to be used in a beginning sport fishing class. Instructors can modify it to meet the individual needs of the class based on age, experience level, and the time available. It is intended to be an independent, self-contained curriculum and incorporates not only lesson plans, but also background text material, an extensive glossary, a bibliography, graphics suitable to both photocopying for students and overhead transparencies for the instructor, and lists of other resources, including state and Federal agencies, conservation and other organizations, and names and addresses of companies where fishing tackle and other supplies, equipment, and literature can be obtained.

The lessons have been designed to be taught in a classroom, but in addition to teachers, can be utilized by 4-H groups, Boy and Girl Scouts, YMCA and YWCA, Boys Clubs, interested individuals, recreation departments, service organizations, and others. The material is readable and can be utilized by any interested group or individual.

Organization of the Manual—The manual is divided into four major units of study. These are subdivided into twenty-eight individual lessons which can be organized at the teacher's discretion and taught in any preferred order. Each lesson is self-contained. Hence, the material can be utilized in any order desired. There is an additional lesson on Careers that can be incorporated at the option of the instructor.

Each *Lesson Plan* contains objectives which identify what the students should know or be able to do after the lesson has been completed. The lesson plans also provide a list of needed materials, an outline of the lesson content, and suggested classroom procedures.

Background Material is provided for each lesson in the form of a textbook. This material can be utilized by the teacher, as needed, and provides the background necessary to present the content of the lesson. The instructor should read this prior to teaching the lesson. The least it will do is refresh the memory and possibly will suggest content that might not have been included as part of the lesson.

Graphics are provided in the Appendix for nearly every lesson. They have been designed both for the instructor and for members of the class. They are suitable for photocopying for the students to take with them and for the teacher to use while presenting the course content if overhead transparencies are prepared in advance. Some of the graphics may be utilized for several lessons and advance planning for their presentation is suggested.

INSTRUCTOR PREPARATION

An instructor for the Aquatic Resources Education Curriculum has a very vital role in determining the success of the class for which responsibility has been taken. Advance planning is essential. One must read the Instructor Manual and become thoroughly familiar with its lessons and other "teacher friendly" elements. If all of the lessons are not be utilized, selection and placement of those chosen may be organized in the front of a three-ring notebook in the preferred order. The instructor is now ready to begin preparing for the class.

Review the graphics to determine which will be utilized for each lesson selected. Then locate a photocopy machine for preparation of student handouts and overhead transparencies. Check with the local school system, a local business, the library, or a commercial print shop to determine both availability and cost.

Review the appendices and determine what equipment and materials are needed for the class. Prepare letters, on letterhead stationery if possible, requesting the teaching aids desired and quantities needed. Realize that there may be cost involved with some items of equipment and material. Ask for prices and be certain to indicate that the Aquatic Resources Education Curriculum is being taught. Allow the time necessary for a response and a second letter from you, if necessary to order the materials.

Organize a list of the outside speakers desired and needed. Contact them for specific times and topics as far in advance as possible. With their special skills and knowledge, they are in demand and their calendars fill rapidly.

Visit the classroom or other teaching location. Determine what items will need to be acquired and what is presently available. Look for screens for the overhead transparencies, the type and style of desks or tables, audio-visual equipment, such as overhead projectors and film projectors, the availability of bulletin boards or other areas to place posters or pictures, and make a list of what the instructor needs to provide.

Investigate potential lakes, ponds, or other types of locations where field trips can be conducted to allow the students to practice what they have learned. There are numerous possibilities for field trips as the class progresses. However, potential locations need to be identified, permission must be secured, costs involved should be considered, and the possibility of fishing from the bank or from boats can be determined.

Adequate preparation by the instructor will enhance student learning and an orderly progression through the curriculum. Increased knowledge, an understanding of the aquatic environment, improved fishing skills, and a commitment to a course of personal responsibility for aquatic resources will result from effective teaching brought about though efficient advance planning.

UNIT I

A FISHING PRIMER

LESSON 1

The Evolution and History of Fishing

13

LESSON
1

The Evolution and History of Fishing

Lesson Objectives

Following this lesson students will:

1. Understand why people fish.
2. Know the difference between subsistence, commercial, and sport fishing.
3. Understand both the social and economic importance of fishing.
4. Be aware of problems and conflicts in fishing.

Materials for the Lesson

1. Copies of the graphics to use as overhead transparencies or as photocopies for individual students.
2. A net or seine.
3. A gig.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	1. Introduce students to the objectives of the lesson.
II. Why People Fish A. Subsistence B. Commercial C. Sport	2. Ask students why people fish. The three general categories of subsistence (food), commercial (food), and sport (fun) will probably be expressed in some fashion.
	3. Ask the students to define the difference among the three categories and to cite examples of each in your area. Since commercial fishing is not done everywhere, students in some areas may have to discuss examples they may have seen during vacation.
	4. Explain to students that fishing began as a search for food, but has developed into a popular sport and leisure-time activity. Somewhere in the process of evolving, commercial fishing was developed.
	5. Using the handouts and overhead transparencies, discuss how primitive people caught fish by hand fishing, clubbing, nets, spears, gorges, and early hooks. Describe a weir, and explain that they were early types of fish traps. Ask students if they think it would be difficult to catch fish using these methods. Let them respond. Show the modern net and gig and explain that primitive nets made from vines, etc., were not nearly as effective as those available today.
	6. Discuss how commercial fishing developed as humans began to subdivide tasks for the benefit of society as a whole and peoples specialized as food gatherers, farmers, etc. as societies advanced. Thus a few people would provide for a larger number and then barter or sell their products. Explain that this has now advanced into a very sophisticated industry. Use the overhead and transparency to show the modern commercial fishing boat and the commercial net. Explain how these work to catch the fish commonly found in fish markets and grocery stores.
	7. Note that most commercial fishing is practiced in salt water. However, in fresh water whitefish, perch, and walleye are harvested in the Great Lakes.
	8. Explain to the students that the majority of this aquatic education fishing course will emphasize sport fishing, one of our most popular sports. Depending on your location you will emphasize salt water or freshwater fishing, or in certain areas, especially those states bordering the ocean, a combination of the two types.

Lesson Content Outline	Classroom Procedure
	9. Determine the primary types of fishing that students have done, the types of fish they have caught, and if they have fished from boats. Conduct a brief discussion of what they have most enjoyed, most disliked, and what they want to learn from the course.
III. Social and Economic Impact of Fishing A. Commercial B. Sport	10. Discuss the social and economic impact of both commercial and sport fishing. Ask the students to name some direct ways this can be seen such as specific jobs, businesses, and groups of people that have developed as a result of fish and fishing. List these on a chalkboard. 11. Explain that much in addition to fishing skills will be taught during the remaining sessions. Conservation and management, ethics, biology, ecology, and their individual role in preserving and enhancing our aquatic resources will be stressed. Discuss why these are important to them as individuals and to our society.
IV. Quality vs. Quantity in Sport Fishing A. Quantity B. Quality C. Fisheries Goals	12. Ask students to define quality and quantity in sport fishing. Generally, quality refers to large fish and quantity to numbers of smaller fish. Philosophies differ on which is best, a few large fish to catch or lots of smaller or average-size fish. Perhaps a good solution in many areas is the availability of a lot of fish with some of them being large to add some "special" excitment to fishing. Much depends on what the public demands in a body of water or area. The role of fisheries management is to provide a proper and effective balance. Ask the students what they would like, to catch a lot of smaller fish or a few large ones. What is their role in this matrix? This could be an appropriate time to introduce the concept of "catch and release" that is widely practiced and what effect it can have on the resource.

INTRODUCTION

This lesson will help the students become aware of the reasons for interest in sport fishing, the importance of fishing as a commercial endeavor, and the problems and conflicts that arise between sport and commercial fishermen and between sport fishermen of differing interests.

The differences between commercial, subsistence and sport fishing methods will also show how and why some are accepted as "sporting" while other methods better suited to taking more or larger fish are not suitable for general sport fishing. This lesson also will stimulate thinking about aquatic resources that will be considered in later lessons on fisheries management, fisheries conservation and fishing ethics/personal commitment.

NARRATIVE

General

Early man lived as a hunter. The term "hunter" in its broadest sense differentiates from later periods of early man during which he became a farmer, growing crops and harvesting food for both immediate and long-term needs.

Subsistence fishing is a form of hunting, as is hunting for animals for food and clothing, or hunting for roots and berries for food. Utilizing the waterways to hunt for and gather fish for food was an extension of mankind's early needs and methods of survival.

As mankind began to subdivide tasks for the benefit of society as a whole, and as survival tasks became easier and more productive, some members of a clan or tribe specialized in gathering food—hunting for food—which included fishing on a scale large enough to feed the entire social class or order. This was the forerunner of commercial fishing today in which a relatively few fishermen gather large quantities of fish by netting, dredging or hooking to feed many people who perform other tasks.

Sport fishing is completely different since it is a sport, one of the few—along with falconry, hunting and riding—that was established in medieval times. Sport fishing is fishing for enjoyment as perceived by the individual. Sport fishing includes the capture of fish for food, the challenge of catching the fish, the enjoyment of being on the water, the comraderie of others involved in fishing, the appreciation of being outdoors, and the enjoyment of related hobbies, such as fly tying, rod making and taxidermy.

Why People Fish—Subsistence Fishing

The reason for subsistence fishing is very simple. People must have food and fish are good tasting, nutritious and often easy to obtain. For early man, subsistence fishing was an extension of his basic hunting survival method. Today, subsistence fishing is rarely found in the more developed countries, although pockets of impoverished peoples use crude sport fishing methods with the goal of getting food to eat—in essence, subsistence fishing. For example, many American Indians today fish with sophisticated tools and utilize the food for their subsistence.

Underdeveloped areas of the world still practice subsistence fishing methods. In some cases, more advanced techniques of gathering fish destroy fish habitats and reduce fish populations beyond their ability to reproduce. Examples of destructive techniques include the use of fish poisons, explosives and strong, modern nets and traps.

Nets are, and were, perhaps the most basic way to get fish for food. Early nets were made of vines, roots, grass, animal sinews and flax, while modern ones are constructed of braided nylon and monofilament line. Nets allow the capture of large numbers of fish as follows; (1) by enclosing a certain area of a body of water and gradually decreasing the enclosed area to concentrate and grab the fish; (2) by netting across a river to ensnare fish (as with gill nets) as they migrate or make spawning runs, (3) and by trapping and channeling fish into holding pens, weirs, or corrals for capture and use.

Weirs are nothing more than traps such as holding pens or nets, into which fish swim or are run for capture by waiting fishermen. Weirs are made of piles of stones or stakes to channel fish and water, or a combination of stakes, stone piles and netting. These weirs are usually built along the side of streams where they can be used to channel fish into the shore or holding pens, or to places in the riffles (shallows) of rivers in order to concentrate and capture fish making up or downstream runs and migrations. Weirs are seldom used today due to the cost of construction compared to more effective, modern methods of trapping.

Likewise, harpoons and gigs have been used for subsistence fishing, consisting of single (harpoon) or multiple (gig) barbed spears. The barbs prevent the fish from sliding off the spear and being lost. Many types of harpoons and gigs have been used, with most having been designed for shallow water fishing by primitive groups who wading or fished from small boats and canoes. Such harpoon and gig heads were made of bone, antler, horn or stone.

Hooks and gorges made of animal and fish bones, shells, gourds, chipped stone, bronze, antlers, and horns have been used for thousands of years for subsistence fishing. Gorges were straight lengths of wood, usually no more than several inches long, with a groove in the middle for tying the fishing line. When bait was attached and swallowed, the gorge would turn in the fish's body and could not be dislodged, making it possible to land the fish.

Hooks of the past were almost identical in shape and principle to those used today. They had the same typical hook shape, a sharp pointed end, a barb, and, in some cases (particularly with the hooks of the Bronze Age), with an eye for attaching the line. While these hooks were similar to the sport fishing hooks used today, they were designed for subsistence fishing.

Why People Fish—Commercial Fishing

Commercial fishing is fishing for large quantities of fish to be sold. Commercial fishing is a necessity in modern life. Without it, many people would not be able to eat fish. Commercial fishing provides offshore food species such as swordfish, shark, tuna, and halibut. It is a job, just like banking, running a grocery store, or working as a salesman for a large company. Commercial fishing usually requires a large outlay of money for equipment such as boats, netting, dredges, and operating expenses. The results are always risky since the amount of fish harvested, thus income or profit made, is dependent upon weather conditions, market prices, competition from other commercial fishermen, seasonal conditions, fisheries populations, and fish availability.

Long lines are used to capture offshore species such as swordfish. Some countries also use them to catch billfish (marlin and sailfish). Long lines consist of a main long line, up to several miles or more, off of which run short lines, each ending with a hook and bait or lure. Large floats mark the ends of the line. A boat travels the line, gathering the caught fish and baiting the hooks.

Deepwater species such as sea bass, cod, and halibut are taken by hook and line and deep water nets. Inshore species including flounder, sea trout, perch, shad, bluefish and similar smaller species are taken by net. Salt water commercial fishermen also supply the consumer with shellfish, such as crabs, scallops, lobster, and shrimp.

Commercial fishing is also practiced in fresh water. The Great Lakes provide a tremendous amount of commercial fishing opportunities for whitefish, as well as lake trout and yellow perch. Additionally catfish, buffalo, and carp are found in commercial harvests in several areas across the country. Also harvested in fresh water are sea run species, such as Pacific Coast salmon, that can sustain high yield harvests.

Much fresh water commercial fishing is really fish farming. The "fishermen" buy land, construct ponds or waterways, and stock species to raise and later sell, just as a cattle farmer buys land, raises cattle and sells them for a profit. Species produced in this manner include rainbow trout and catfish.

Other types of commercial fishing gear include purse seines (the bottom of the net closes after the net is placed around the fish), pound nets (traps to capture fish), gill nets (either floating or anchored and designed to snare fish by the gills), and haul seines (designed to be pulled to shore with fish).

Why People Fish—Sport Fishing

Sport fishing is fishing for enjoyment. The definition varies widely, thus interest occurs in many different forms of sport fishing. It is not fishing for subsistence, even though the catch is often eaten, since such catches, while important to many anglers, are not required to sustain life. It is not commercial fishing for which the angler will be paid for his catch.

Sport fishing methods vary widely. They include everything from fishing with a handline and simple hook, bait, and sinker for bottom feeders, to sophisticated and often expensive methods such as offshore or Great Lakes trolling and fly fishing. Some anglers have fun just by being outdoors and often combine fishing with boating, picnicking, camping, and backpacking.

Some anglers enjoy the solitude possible by "getting away from it all." Others like the comraderie possible with certain types of fishing such as charter boat, party boat, pier or jetty fishing where many anglers are present.

Other anglers like to catch fish for the fun of getting something different to eat. Many like to fish with certain gear or in certain ways, such as fly fishing, fishing only with artificial lures, trolling, surf fishing, or fishing with light tackle, Still others fish to establish records for the International Game Fish Association (IGFA) line classes or to participate in tournaments. Many anglers use fishing as a hobby that can be enjoyed throughout life. They may become further engrossed with the side aspects such as fly tying, rod building, taxidermy, lure making, boating, and entomology (the study of insects for fly fishermen).

It is important to remember that fishing can be different things to different people and still provide immense enjoyment. It can be contemplative or intellectually stimulating, relaxing or physically demanding, simple or complex, inexpensive or extremely expensive, practiced from shore or from a boat, enjoyed by one of almost any age, constantly or infrequently, and practiced almost without concern for season, weather, time or temperature. However, the primary goal of all of these people is to catch a fish.

SOCIAL AND ECONOMIC IMPACT OF FISHING—COMMERCIAL FISHING

Commercial fishing is not primarily a social activity. It is a job and is done as an income producer. This does not mean that it is not enjoyable or that there are no social interactions on the job, only that commercial fishing is not done primarily for enjoyment. There is, however, great impact on the population as a whole. Commercial fishing allows food stores throughout the country to stock fresh, frozen, dried, smoked, canned, and salted fish of many species. This benefits society by providing variety in the diet, healthful food, and delicious meals that otherwise would be impossible for many to obtain. Even sport fishermen would normally be restricted to consuming a few local species of their own seeking were it not for commercial fishing endeavors.

The economic impact is also important. Commercial fishing provides employment for fishing boat workers, boat captains, fish farmers, canners, boat owners, fish processing plants, shipping and trucking industries, food wholesalers, food stores and restaurants. There is also a "ripple effect", as with any industry, which benefits a number of other industries including food, housing, clothing, auto, gasoline, and convenience store sales. In the past, entire coastal towns have been built around and prospered as a result of commercial fishing.

Social and Economic Impact of Fishing—Sport Fishing

Sport fishing can offer a high degree of social interaction. An example is a fishing class, where students and instructor(s) are gathered together to learn more about fishing, aquatic biology, and how to enjoy the sport.

The degree of social impact can and will vary with the angler. Some anglers consider fishing a solitary sport to be enjoyed alone, away from all possible signs of civilization and other people. Usually, they are in the minority as most anglers enjoy social aspects of the sport.

This interaction can take many forms. Many anglers fish and gather together to discuss fishing with family members and close friends. Others are involved in a neighborhood or area fishing community, exchanging tips, and information, and occasionally fishing together. Some join or start fishing clubs. Such clubs are local although they may be affiliated with larger national organizations. Groups such as Trout Unlimited, The Federation of Fly Fishermen, Bass Anglers Sportsman Society, and Operation Bass are among a number of large national groups. Usually these groups have a common interest in a species,a method of fishing, or a geographical area.

The individual must make of the sport what he/she will and determine an appropriate level of involvement. The social activities of an active fishing club can be extensive. Fishing trips, club tournaments, monthly meetings, seminars, youth instruction, legislative lobbying for sport fishing goals, picnics, conservation efforts and stream improvements, fish rearing and stocking, and annual fund raising banquets can be as extensive as that of any other club or interest in American life.

While the economic impact of sport fishing is seldom realized, it has tremendous importance and can be measured through license sales, angler dock surveys, questionnaire surveys and similar means. The economic importance, when accurately measured for some species, has been found to surpass that of the commercial impact for the same species. Part of this is due to expenditures for rods, reels, line, lures, hooks, bait, boats, motors, electronics, launch fees and slip fees, as well as expenses incurred traveling to the fishing site for gas, hotels, and food.

Sport fishing is also important for the "ripple" economic effect felt throughout a community. Expenditures for gasoline, lodging, meals, convenience stores, restaurants, tackle, clothing, camping areas, and boat rentals are quite large. In addition, the ripple effect throughout the community, region or state as those anglers' dollars circulate aid secondary suppliers and manufacturers of the goods and services used by sport anglers. Some communities have purposely capitalized on fishing interest or have sponsored fishing tournaments, for their economic impact and value to the business community.

The value of sport fishing, according to the Sport Fishing Institute, shows that in 1985, anglers spent approximately $25 billion in pursuit of their sport. In contrast, the approximate dockside value of commercial landings (fish catches) for the same period was $2.3 billion with the equivalent retail value reaching $9.2 billion.

Quality vs. Quantity in Sport Fishing

Since sport fishing can encompass many different philosophies, ideas, degrees of interest, and concepts of enjoyment, there are also widely varying ideas toward the use of the catch. On one hand are those who would like to catch as many fish as possible for food or for "show and tell." Other anglers release every fish they catch, with their pleasure coming from their ability to catch the fish. The philosophy of "Catch and Release" began with trout and salmon fishing but today is becoming more widespread to include bass fishing and salt water tournaments.

The merits of the quality and quantity of the catch are often discussed. Whether wild or stocked, fish caught in large quantities are usually of small or average size. When only a few fish are caught, they are usually quality or larger fish. Considering that only a few fish live to become large or trophy size fish, quantity catches of smaller fish usually are more common than catches of large fish. As a result, most fish are harvested before they reach a quality size. Fish management can control the harvest to a degree with variations of creel, size, and slot limits.

In some cases, quantity and quality is not a problem. Species such as Atlantic mackerel, catfish, stocked trout, river smallmouth bass, carp, panfish, perch, and crappie will rarely gain sizes disproportionate to that of the rest of a school or area. There are exceptions such as the few trophy trout stocked with smaller rainbow trout in some trout streams and the occasional trophy smallmouth in with hundreds of smaller catchable fish.

In these situations, size as a measure of quality is not a problem since few anglers are searching for a trophy perch, crappie or Atlantic mackerel. Often these are the species that are most popular for food, so a trophy is a less important goal than catching enough fish for a good meal.

The role of fisheries management is to adjust a population of fish to meet the demands of the sport fishing public. When consistent with costs, biological parameters and reasonable planning, the goal is to give the public a proper and effective balance of quality fishing and quantity catches.

Another aspect of quality fishing involves the environment and conditions under which the fish are caught. Some early season trout fishermen will follow hatchery trucks and gather shoulder to shoulder around holes where trout are stocked. Others prefer to go to areas where only wild or native trout are located, avoiding any stocked areas.

SUMMARY

Fishing has had a long history beginning with subsistence fishing. Commercial fishing even though is still important economically and for the food available as a result. Sport fishing has gained tremendous popularity and today far surpasses commercial fishing in direct economic importance.

An appreciation of sport fishing involves not only an understanding of the history and the various types of tackle used for recreational use but also a knowledge of the relationship between quality and quantity fishing and the reasons leading to the enjoyment of sport fishing.

LESSON 2

How to Catch a Fish

LESSON
2
How to Catch a Fish

Lesson Objectives

Following this lesson students will:

1. Recognize fish which are popular for catching and eating.
2. Understand basic fish migrations and movements and why these occur.
3. Understand basic methods of catching fish.
4. Be able to identify basic equipment including hooks, sinkers, floats (bobbers), and line.
5. Understand how water quality and fish biology affect the species available in certain types of water.
6. Recognize common baits, how to use them, and where to find them.

Materials for the Lesson

If possible, each student should be provided with:

1. 100 yards of monofilament line, 4–10 lb.
2. One float, 1–2" diameter, plastic.
3. Earthworms and/or minnows—1 or 2 per student.
4. Several hooks size 1–6, with a regular shank length.
5. Several pinch on sinkers, 1/4 to 1/2 ounce.
6. Clothesline rope—5 feet per student.

Other Materials

1. Photocopies of graphics in appendix and overhead transparencies for teacher use. Useful are those of several locally popular fish and the graphic showing the clinch and improved clinch knot.
2. Cane poles and spincast outfits—1 per every 3 students.
3. Casting practice plugs, 1/4 and 5/8 oz.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	1. Introduce students to the lesson objectives.
II. Where Fish Live A. Freshwater B. Saltwater C. Brackish D. Other Considerations	2. Discuss fresh, salt, and brackish water and the species of fish that live in each. Concentrate on those that are popular in your area and utilize photocopies and overhead transparencies of these fish during the discussion. 3. Discuss how seasons, water temperature, currents, and oxygen levels affect what types of fish will live in certain bodies of water and that it is important to know about these to increase angling success. Relate that different species have different requirements of water quality and temperature along with the other factors and these have a tremendous influence on the fish available.
III. Types of Fish A. Freshwater 1. Cold Water 2. Warm Water B. Salt Water C. Anadromous	4. Explain that freshwater fish are generally considered either cold or warm water fish. Trout and salmon are cold water species, with bass and catfish considered warm water. Some saltwater fish ascend streams or rivers to spawn and are called anadromous species. Shad, salmon, and trout are anadromous.
IV. Simple Tackle and Equipment A. Hooks B. Sinker C. Bobber D. Line E. Rod/Reel Substitutes 1. Hand Lines 2. Tin Can/Oatmeal Box	5. Discuss fishing tackle needed to catch fish. Distribute the line, floats, hooks, sinkers, and rope to the students. Using the overhead transparency and a piece of the rope to demonstrate, teach the students to tie a clinch knot. After practicing with the rope, have each student take a length of monofilament and a hook and practice tying the line directly to the hook. 6. Again, use the overhead transparency to show the various riggings for fishing. Have each student prepare a rig with the hook, a pinch on sinker, and float on 6–8′ of line. Show a similar rig on a cane pole and also on a spincast outfit.
V. Bait A. Worms B. Minnows C. Insects D. Local Baits E. Prepared Baits	7. Ask students what else, if anything they need for fishing. The obvious answer is bait. Use the overhead transparencies and photocopies to show common baits for stillfishing and how they are attached to the hook. Use the live bait, worms or minnows, distribute them to students and have them bait a hook. Expect some of them to be reluctant. They can compare their product to the transparency or photocopy. After they all have successfully completed this activity have them clean their hook and place the bait in a waste basket.

Lesson Content Outline	Classroom Procedure
VI. Easy Methods of Catching Fish A. Still Fishing B. Casting C. Trolling	8. Ask students how the bait is placed where a fish can eat it. Still fishing, casting, and trolling may all be mentioned. Explain that still fishing will be emphasized. Demonstrate how to use both the cane pole and spincast outfit to place the baited hook where it can be taken by fish. Stress the importance of safety and the difficulty of placing the baited hook with a float on the line. 9. Move the class outdoors or into a gym where swinging the bait can be practiced for a few minutes. Again demonstrate and then distribute the equipment evenly to the students to that while one attempts swinging the bait, 1 or 2 others can watch. A hand coiled line can also be used for this exercise with the excess line coiled on the student's hand, on a tin can, or a small oatmeal box. Keep students widely separated to minimize the chance of an accident and use casting plugs on the lines rather than hooks. Spincast outfits can also be utilized in this activity. You may wish to review lesson 8.

INTRODUCTION

This lesson will provide the necessary background for students to catch a fish. While a discussion of hooks, bait, line, floats, and sinkers is advisable before beginning, much of this lesson will be devoted to fishing. Since most of the lessons are designed for 45 to 60 minutes duration, this lesson may be planned in two parts. First, have a class meeting and discussion to accomplish the lesson objectives. Near the end of the lesson, plan for a fishing outing before the next lesson is presented.

It is important to emphasize that fish live in virtually any body of clean water, that clean, pure water is invaluable for all of us, and that most anglers can find fishing of some type near home.

Where Fish Live

Fish can be found nearly everywhere there is water of sufficient quality. Types of fish vary with the water quality. For example, carp have lower requirements for water quality, oxygen and food than trout. Nearly everyone can find fishing within a short distance of home.

Fish populations are limited, so one must be careful to catch and keep only those fish that he or others will use for food. Fish can be released without injury, and this will also help provide fish for future fishing trips. Fishing regulations are designed to keep fish populations from being depleted and to spread the resource among anglers for years to come.

Freshwater Fish

Freshwater fish inhabit streams, rivers, and still water such as lakes, ponds, quarries and gravel pits. The type of water will usually determine the species of fish one can catch there. Lakes and ponds are typically the home for panfish (any number of small sunfish or related species), bass, trout, members of the pike family, carp, catfish, walleye, crappie and increasingly, striped bass and hybrid striped bass. Rivers produce and hold fish that can live in currents, but much overlapping with still water species occurs. Smallmouth bass, catfish, carp, trout, and walleye are commonly found in both stillwater and water with current.

Saltwater Species

Saltwater species also vary, depending upon where they are located. Ocean fish are free to roam in deep water, often following defined ocean currents like the Gulf Stream (coming up from the south in the Atlantic), the Labrador Current (flowing from the north in the Atlantic), and the Humboldt current (located in the Pacific). Other currents control the movements of fish such as marlin, dolphin (the fish—not the mammal), wahoo, sailfish and sharks.

Species caught inshore include striped bass, sea trout, tarpon, sea bass, bluefish, cod, and flounder. These depend upon protected bays and estuaries and have limited movement in open ocean water. They do have migratory movements that vary greatly by the species. Some migrate only a few miles while others may migrate inshore along much of a coastline. In most cases, migrations occur primarily during spawning and fluctuating (summer-winter) water temperatures.

Brackish Water

Many species can be found along the coast in the mix of fresh and salt water, often called brackish water. Brackish water contains salt but is diluted by freshwater entering from rivers and streams along the coast. As a result, in "river mouth" areas, the quantities and quality of fish and of fishing can fluctuate with salinity levels. Salinity fluctuates daily with the flow of tides and rain (more river water and thus more dilute) or drought (less rain and thus higher salinity) conditions.

Species that live in brackish water will vary by geographic area. They include striped bass, largemouth bass, sea trout, flounder, white perch, snook, redfish, bluefish, rockfish, sea bass, cod, croaker, sheepshead, cabezon, and others.

Other Considerations

Other considerations in finding fish are seasons and water temperature. Lakes and ponds are termed cold water or warm water lakes by fisheries biologists. Cold water lakes typically are more prevalent in the northern half of the country and contain species such as trout, walleye, northern pike, and salmon. Warm water lakes hold species such as largemouth bass, carp, catfish, and sunfish.

Seasons also determine the movement of fish. Many fresh and saltwater species such as largemouth bass, striped bass, yellow perch, salmon, and shad migrate based on spawning habits. Some fish such as lake trout and Pacific salmon follow temperature gradients in large bodies of water that stratify (develop layers of different temperature and oxygen levels) during the summer months. Many saltwater species also follow seasonally changing temperatures in ocean currents such as the Gulf Stream.

Types of Fish

Fish that can be caught by hook and line are common everywhere. They include popular species such as bass, walleye and salmon, along with species that are less famed but equally as much fun such as carp, catfish, suckers and sunfish.

Fish have certain requirements to live, one of these being a specific range of water temperature. These include the trout and salmon as cold water fish, with the bass, bullhead, carp, and catfish as warm water fish. In addition, most saltwater species will follow specific temperature gradients, thus the influx of certain species during certain times of the year along coastal areas. In many cases these fish are following salt water currents, such as the Gulf Stream (Atlantic Coast), which do change seasonally.

Some fish live in saltwater but ascend streams and rivers to spawn. These fish are called anadromous, which means that they are freshwater spawning, and include shad, salmon, and trout.

Simple Equipment

To catch fish requires basic equipment. Many fishermen ultimately obtain extensive equipment (discussed in later lessons), but simple items are often adequate to catch fish. An angler can have as much fun fishing for small fish with a hand line, hook, sinker, and float as with more extensive equipment.

With any equipment, it is necessary to get the bait to the fish. One can begin with cane poles and flexible willow branches for starters, although some students may well have more sophisticated tackle. When working with students who lack tackle, hand lines can be coiled and thrown into the water using a sinker for weight, or line can be tossed from a Coke bottle used as a rudimentary spinning "reel". A tin can or large round box will also work.

Bait

To catch any fish, a bait or lure is needed. Bait can be anything placed on the hook that the fish will accept as food. Typical baits include *Worms*. Worms are fine for nearly all fresh and saltwater fish, although special sea worms are often used in salt water. While the hooking methods are the same, sea worms cannot be collected as can earth worms. To find worms, dig in any rich garden area or better still, turn over boards, bricks, logs, or other objects, since worms will often be located underneath.

There are several ways to hook worms. If the worms are small, the best way is to thread the hook through the sides at several points along the body. For bait stealing fish, thread a short piece of worm on the hook until it is completely covered.

Rigging Bait

For a simple rig, tie the hook to the end of the line with a clinch knot. Place a pinch-on sinker 12 inches above the hook. Fasten the line under one "ear" of the pinch on sinker, wrap the line around the sinker once to hold it in place, and fasten the line again under the other "ear." This allows sinker adjustment if needed, yet will prevent the sinker from sliding. Place the float one to three feet above the sinker, or as required for the fishing.

Minnows

Minnows can be purchased from bait shops or caught in streams. However, check local regulations, since a fishing license may be necessary and netting or trapping minnows may not be legal in some areas such as trout streams. For long life, minnows must be kept cool in a special minnow bucket or trap. Do not overcrowd minnows in a small container. To hook, the best method is through both lips, running the hook up through the bottom lip. This will work well for trolling, casting, and still fishing. Other methods are hooking through the tail or through the back, but (avoiding the spinal cord, thus paralyzing the minnow).

Insects

Both land and water insects can be used. Capture them with a net. Often land insects can be caught using a large minnow type net, by walking toward the net to scare insects into it. The same technique can be used in the water with a minnow net.

Good land insect baits include grasshoppers, crickets, caterpillars, cicadas, and gall worms. Good water insects include hellgrammites (larvae of the dobson fly), dragon fly nymphs, and caddis fly cases. When using insects, get thin small hooks or those that are designated as "light wire" to avoid damaging the insect and to hook through the whole insect. To get longer use out of each insect take light copper wire and wire the unharmed insect to the hook shank.

Other Baits

Some baits are regional and quite effective. Leeches are good in the north central part of the country for a number of fish, including bass, walleye, and sunfish. In salt water areas, strips of squid, and cut fish and pieces of eel are good baits. Clams, in both fresh (found in many rivers) and salt water are ideal when carefully threaded on a hook. Pieces of crab are commonly used along the coast where pieces of peeled shrimp tail are also excellent.

Prepared Bait

Dough balls can be used for carp and other bottom feeders. Bread, small squares of cheese, and canned corn are also good. In most cases, these prepared baits are hooked so that they cover the hook.

Easy Methods of Catching Fish

Several types of rigs can be used for fishing, including the following:

1. Float rig—This consists of a hook tied to the end of the line, a sinker 12 inches above it, and a float three to four feet above that. It is ideal for holding a bait in mid depths for small schooling fish to find.
2. Bottom rig—This is the same as above, with the exception that the float is removed. The bait lies on the bottom where bottom feeders can find it.
3. Bottom rig-variation one—Fish are also fished on the bottom, but differs in that the sinker is tied to the end of the line, and a short piece of line (leader) is tied 18 inches above the sinker with the hook tied to the end of the leader. This leader is usually about 12 inches long. This method, when fished straight down as in still fishing, prevents the bait from lying completely on the bottom where fish might miss it.
4. Bottom rig-variation two—This is just like the above, with the addition of a second leader and hook about 18 inches above the first, to double chances of hooking a fish.
5. Drift rig—If the bait is heavy enough to throw, swing or cast, it can be used to drift in the water without any float or sinker. This is best when fishing where there is a slow moving current, tide, or water flow.

The above can be used with a hand line dropped from a shore based point, a boat, or swung out with a long pole to place the bait away from the bank or fishing base. Casting of sorts can be accomplished by swinging the bait/sinker around and throwing it out into the water. With practice, which should be done by young students before giving them the hooks, considerable distance can be obtained.

Trolling, while usually not applicable here, involves a moving boat. In this case, baits such as minnows are trailed over the stern of the boat to attract fish. Only a few lines can be used this way from most boats and a very slow speed is necessary. Sinkers are usually needed to get the bait down to the fish. Trolling is not recommended at this time unless class is very small, several boats are available, and conditions warrant this type of fishing.

Remember, the single most important result of this lesson must be to help students catch a fish—or several fish—to generate the enthusiasm for continuing the course and to learn in far greater detail all about fish, aquatic resources, conservation, ethics, tackle and fishing method!

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LESSON 3

Aquatic Communities—Where to Fish

LESSON
3

Aquatic Communities—Where to Fish

Lesson Objectives

Following this lesson students will:

1. Know how aquatic habitats differ from each other.
2. Be familiar with different types of lakes and streams.
3. Know how the type of water determines the aquatic community.
4. Be able to identify the species that are most common in each type of water.
5. Understand why each species lives in a specific habitat.
6. Know how to approach and analyze fishing waters.
7. Be able to fish different waters with some degree of success.

Materials for the Lesson

1. Photocopies and overhead transparencies produced from the graphics depicting the differences among lakes in different geographical areas.
2. Photocopies and overhead transparencies produced from the graphics on the dynamics of a stream and an estuary.
3. Use of other graphics as desired.

TEACHING STRATEGY

Lesson Content Outline

- **I. Lakes and Ponds**
  - A. Characteristics
  - B. Species Present
  - C. How to Read the Water
  - D. How to Fish
- **II. Streams and Rivers**
  - A. Characteristics
  - B. Species Present
  - C. How to Read the Water
  - D. How to Fish
- **III. Estuaries and Bays**
  - A. Characteristics
  - B. Species Present
  - C. How to Read the Water
  - D. How to Fish
- **IV. Wetlands**
  - A. Characteristics
  - B. Species Present
  - C. How to Read the Water
  - D. How to Fish
- **V. Oceans**
  - A. Characteristics
  - B. Species Present
  - C. How to Read the Water
  - D. How to Fish

Classroom Procedure

Based upon your geographic location, you may wish to teach all or just the most pertinent sections of this lesson. Also, you may wish to invite an outstanding local angler to discuss fishing in local bodies of water, what species are present, and successful angling techniques. You may also wish to view the lesson plan for lesson 23 for additional suggestions.

1. Introduce class to the lesson objectives.
2. Discuss the different types of aquatic communities described in this lesson. Mention that there are obvious differences in these major categories, but that there are also differences within each category based on their latitude or elevation, depth, shape, and water quality. These factors determine the kinds of fish present and their distribution. Additional factors in moving waters (streams and rivers) are the gradient, temperature, and substrate. Indicate that these factors will be discussed and that understanding them is a major factor in successful angling.
3. Spend the majority of class time focusing on types of waters in the local area. For each type, follow the lesson outline and discuss their characteristics, the species present and why, how to approach and analyze the water, and specific angling techniques.

Additional Suggestions

1. Talk about ponds and how productive they can be. It is easier to show the features of a pond than a large lake. Stress the fact that every body of water must be broken down into workable sections from an angling standpoint.
2. Explain the basics of stream dynamics and how flowing water differs from stationary water. Discuss how the same stream or river can have fast and slow water, depending on the gradient.
3. Focus on the importance of an estuary as a mixing zone where fresh and salt water meet. Discuss how fragile this area can be and how important it is to the survival of many species.
4. Wetlands are often thought of as wastelands. Stress that they are among the richest land in America. Discuss their importance.
5. Oceans cover three-quarters of the earth's surface. Dispell the myth that they are an endless well of unlimited fishery resources. Stress that they are fragile and how temperature is the main factor in determining the species in any given location.

Lesson Content Outline	Classroom Procedure
	6. Compare lakes and ponds to nearby streams and rivers, explaining that both often hold the same species of fish. Discuss the factors that cause this to be true. 7. Make certain that students understand why certain species favor specific types of water and that water temperature is the primary factor determining what species will be where. 8. Determine that students understand the basics of finding the best spots, know how to approach fish quietly, and know why a bait or lure should be presented in a realistic and natural manner.

INTRODUCTION

To catch a fish the angler must first locate them, determine an approach, and then select appropriate fishing methods. When fishing is done in this manner, the results often prove successful. Finding fish is often a difficult activity. Regardless of the type of water in which they live, fish have specific requirements for survival that include good water quality with adequate oxygen, tolerable temperature, and adequate food and cover. If one of these factors is eliminated fish cannot remain very long.

All water does not contain fish, so the angler must learn to identify areas that might have fish. This takes time and practice but is the key to successful angling. Each species prefers a certain habitat. Understanding the relationship between habitat and fish habits and recognizing where the habitat exists help the angler experience success.

Nothing in nature is static. Water conditions and characteristics change constantly. A swiftly flowing creek may slow significantly during the summer months with a drop in water level. Stratification in lakes reduces oxygen near the bottom of deeper water. Anadromous species migrate from salt water to fresh water to spawn and seasonal migrations affect where fish will be and when. As a result fish must continuously adjust to such environmental changes. Therefore the angler who learns these patterns is better equipped to locate fish at any time of year.

NARRATIVE

Lakes and Ponds

Lakes are generally inland bodies of fresh water. Many were formed naturally by glacial action, movement of the earth's crust and changes in the course of a river. Others have been created by blocking flowing water to create an impoundment. Most impoundments have been developed to generate electricity, to control flooding, or to serve as drinking water reservoirs. A river bed usually runs through an impoundment and all have some form of inlet and outlet.

Ponds are miniature lakes. Most are bowl-shaped and many are found on farms as a source of water for crops or livestock. A creek or other source of flowing water empties into a pond, often with an outlet on the other side. An incredible number of ponds dot the landscape and offer surprisingly good fishing. Many ponds in inner city parks have abundant fish populations and provide enjoyment for anglers who cannot escape to the country.

Characteristics

Surrounding land has a pronounced influence on the characteristics of a lake or pond. Those located in farming regions which can be rich in nutrients are classified as "eutrophic." Organic matter falls to the bottom where it decays, using oxygen in the process. During summer, a lack of oxygen may occur in the lowest layer called the "hypolimnion," eliminating this habitat for most fish.

Lakes and ponds go through a lengthy aging process. Eutrophic waters, usually found in limestone watershed areas which yield hardwater, represent some of the best fish habitat for bass, panfish, and other warm water species, but they are vulnerable to degradation. Fertilizers or pollutants from agricultural land often enter the water causing eutrophication which can improve fishing. However, too much of this can be undesireable for fish and the producers in the food chain. Infertile or oligotrohpic lakes, normally found in granitic watersheds which yield softwater, suffer from a scarcity of nutrients and are very clear. These lakes are more affected by acid rain since they are not buffered. They are often very beautiful, but have low capacity for sustained yield to the angler. They are found throughout the far north, in arid zones, and at high elevations. Lake Tahoe is a clear, deep oligotrophic lake.

Geology and geologic processes determine topography, which, in turn, determines lake morphology. Lake morphology, geochemistry, and latitude and/or elevation combine to determine the productivity of a given lake. Fishermen sometimes categorize lakes by location, referring to them as lowland, flatland, hill-land, highland, plateau, and canyon lakes. Lowland lakes include the bayous of Louisiana, the Florida Everglades, and flowages such as the Chippewa in Wisconsin. Flatland lakes are relatively shallow and flat, while hill-land waters are narrower and contain both shallow and deep sections.

Highland waters nestle in the foothills of mountains and are narrow with sharp drop-offs. Because of their depth, they have less vegetation and are much clearer, while Western plateau impoundments are intended for irrigation. Clear, deep canyon reservoirs have virtually no vegetation.

Species Present

Oxygen, water temperature, food supply, and cover determine the species in a particular body of water. Man has sometimes extended the range of some species, such as by bringing carp to American lakes and ponds and by introducing striped bass in impoundments and Pacific salmon in the Great Lakes.

Largemouth bass can tolerate a broad range of water temperatures and are found in the lower 48 states and Hawaii. Smallmouth bass have a narrower temperature tolerance and require clearer and slightly cooler water. Sunfish, bluegill, perch, and other panfish are abundant in warm lakes and ponds. Walleye, muskellunge, pike, and pickerel are found in intermediate temperatures, while trout, salmon, and char prefer colder water.

Lakes that have cold layers rich with oxygen support salmonids in deep waters, while the shallower and warmer areas of these waters may host bass. The Great Lakes, for example, have trout and salmon along with walleye, perch, pickerel, northern pike, bass,and other species. Farther south, these species are replaced with more bass, catfish, carp, and panfish.

If all species struggled for the same place in the aquatic community, the ecological diversity of any body of water eventually would be greatly reduced. Each species carves out a niche that is slightly different from the other species and other creatures. Fortunately, aquatic communities have varied food chains that support many different species. Therefore, a gain in production results from the diverse feeding and space requirements. As a result the harvest should be improved.

How to Read the Water

The principles of analyzing water and approaching fish remain relatively constant regardless of the lake or the species. It is important to understand that subtle changes in water temperature, oxygen, pH, bottom structure, shadowlines, and similar factors make a significant difference in locating fish. Fish tend to locate along transitional zones. The bottom may change from sand to rock or from mud to weeds; a dropoff may occur or slope into deep water; or water in one sector may be a slightly different color. These variations, no matter how minor in appearance, may be the key to successful angling.

Bass seldom stay in open water and characteristically move toward some form of structure. Muskies and northern pike are ambush feeders, lurking in or near weedbeds or an object that conceals them. Catfish and carp probe the bottom whereas trout and salmon remain near the bottom at times, often seeking a spot just above the thermocline. Walleye can be found on points and sandbars in the morning and evening feeding on small fish. Bluegill nest in shallow water in the Spring and later can often be found where weedbeds drop off into deeper water.

Fish are wary. This helps them to survive and can also make them difficult to catch. They utilize their excellent senses of vision and hearing, detect motion with unerring accuracy using their lateral line, and also use their sense of smell. Therefore, a cautious approach is required of an angler.

When fishing from the bank the angler should stay well back from the edge and make casts from a semi-camouflaged position. Also, a low profile makes it difficult for fish to spot the human intruder. Walking quietly helps to mask sound which can be transmitted into the water. Aboard a boat, banging or scraping sounds echo through the water. The sound of an engine also can be a negative factor as well as the wake from a boat as the water crashes against the shore.

Boats should approach a fishing area at idle speed without running over the spot to be fished. The key lies in not disturbing the fish. A silent approach increases the odds for a successful fishing experience.

How to Fish a Lake or Pond

Most fish are opportunity feeders. They select food from a variety of choices in the aquatic community. When an abundance of a particularly choice food is available, they often specialize.

With either natural bait or artificial lures, the presentation must be realistic. It should appear that the offering is part of the normal food chain. Hunger is certainly a major motivating factor, but fish also respond as predators and strike something that moves. At times, they even exhibit antagonistic behavior when biting an intruder to drive it away.

In deciding where to fish, consider the season, water temperature, oxygen, pH, and the types of structure. Try to determine where the natural food supply is located. Once an area is selected, look for transitional zones or edges as well as other significant features, such as a sloping point or the outer fringes of a weedbed. Putting the puzzle pieces together becomes a mental exercise.

Rivers and Streams

Rivers and streams can be a trickling brook, a fast moving stream, or a meandering river. As a stream becomes wider and deeper, it is called a river. However, it is difficult to find a definition that denotes the exact requirements for this change in nomenclature.

Characteristics

In terms of this type of aquatic community, three factors are critical to moving water: gradient, maximum summer temperature, and substrate. Gradient is the rate of fall expressed in feet per linear mile. This determines the speed of the water flow. Within a single stream, the gradient can change several times and will be reflected by the velocity of flow.

As a rule, water volume increases as the stream moves away from its source. Volume is measured in cubic feet of water flowing past a specific point in one second. The faster a stream flows and the more it tumbles over rocks and obstructions, the greater the oxygen content.

Maximum summer water temperature is a key factor in determining the fish species a stream or river can support. Streams are classified as cold or warm water, although the same river may be cold in one section and warm in another. Salmonids require much colder temperatures than species such as bass or bluegills.

Streams carry solid materials toward the mouth of the waterway. Some rivers are muddy or off color because of fine clay sediment which remains suspended for a lengthy period. Others may contain large amounts of sediment from heavy rains and the resulting runoff.

The substrates or bottoms of streams vary from place to place, ranging from stones and rock to mud and sand. Water quality coupled with the substrate determines the insect life that can survive. These aquatic insects are a vital part of the food chain.

Another classification of streams used by some anglers separates free stone streams from limestone streams. Limestone streams are usually spring-fed with a relatively constant water temperature year-around. The typical rocky bottom streams are free stone.

Species Present

Trout and salmon require clear, cold water and relatively high levels of oxygen to survive. This becomes particularly critical during mid-summer and early fall when water temperatures rise, water levels drop, and oxygen may be less plentiful. Unless conditions are tolerable for the salmonids at that time of year, they simply cannot live there.

Insects are a mainstay of a trout's diet. Those streams with a substrate that supports strong insect life should hold more and larger fish. Food choices may vary, but insects are a vital segment of the food chain.

Rivers too warm for the salmonids frequently prove ideal for bass, panfish, catfish, carp, and other species that do not require clear water or cold temperatures. Smallmouth bass inhabit streams, but they require clearer water than largemouth bass. They can also do well in faster moving waters than largemouth prefer. Walleye, sauger and white bass are found in larger and deeper rivers where there is a diversity of water depth.

Streams and rivers often host the same species found in nearby lakes and ponds. There are exceptions in some parts of the country where still waters have bass as the primary species, while streams hold trout and salmon. Anadromous species such as salmon, striped bass, and shad use rivers and streams to spawn. Spawning runs take place in either the spring or fall and can provide excellent sport for those anglers ready to take advantage of this phenomenon.

How to Read the Water

The shallower the water, the more wary fish seem to be. In a deep river, the angler's approach does not have to be quite as stealthy as in a shallower one.

Fish at rest always face into the flow of water. They have a small blind spot behind them, making it advantageous for fishermen to work upstream. Also, any silt or sand dislodged while wading will be carried downstream and not over the fish. For these reasons, downstream wading is more difficult to accomplish successfully without alerting the fish.

Clumsy and careless wading is a primary cause of not catching stream fish. Each foot must be placed down as quietly as possible since the ripples and shock waves emanate outward as the angler wades. To prevent this, movements must be extremely slow.

Fish in a stream generally stay out of the main current, but close enough to grab a passing morsel. If one fish is caught in a particular spot, there is a good chance that another will take its place within a day or so. With experience, an angler can learn to read the water surface and to know what is underneath. Slick places indicate a rock below the surface; the outside bend of moving water will be deeper than the inside of the bend; and rocks, trees and other structure that break the flow should all hold fish.

How to Fish Streams and Rivers

Generally more fish are in a stretch of water than most people realize. Recreational anglers are always amazed by the number of fish present when scientists electro-shock a section of stream to count fish. However, finding and catching these fish is quite another matter. The key for the successful angler centers on understanding the requirements of each species and applying that knowledge to a specific area. Riffles, rapids, springs, or feeder streams entering the main flow increase the amount of oxygen. A simple themometer measures water temperature quickly. Based on the time of year, water temperature, oxygen content, substrate, and structure, an angler can usually determine where fish will be.

In moving water, most species require protection from the current and take up lies where there are pockets of "dead" water alongside the faster flow. A fish will not chase bait very far into the current, but will dart out, grab the prey, and swim back to protection. Slower rivers do not present the same problem, but fish still have to expend energy to hold a position in flowing water.

The best method toward a successful catch is to approach a fishing area carefully and then to present bait so that it appears natural. A free-floating offering such as a dry fly must drift with the current and not be dragged by the leader.

Locations should be selected just as carefully when fishing from a boat. Dropoffs, shorelines, logs, weeds, and other structure hold fish. When the water in a river rises rapidly, fish have a tendency to move closer to shore, looking for food in the newly flooded areas. With falling water, they will ease away from the banks.

Estuaries and Bays

An estuary is a mixing zone where fresh water from streams and rivers meets the salt water of the sea. This forms a habitat which often supports both fresh and salt water life.

Characteristics

The specific salinity content in this transitional zone becomes a critical factor that determines which species will be present. Salinity levels do not remain constant, but vary with the amount of fresh water entering the estuary or the amount of salt water incursion. Brackish water has some salt, but not as high a level as in oceans.

Estuaries serve important purposes. Some 70 percent of all marine species are dependent on this type of habitat during some phase of the life cycle. Others, to survive, feed on forage that requires estuaries. This is also a prime area for spawning and for juvenile fish to feed and grow. The young of many species remain in estuaries for extended periods of time. Food is available in this mixing zone and predators often enter it to feed.

Species Present

Most fresh water fish cannot tolerate salinity levels higher than one to two parts per thousand, and many marine fish have difficulty when the salinity drops lower than an ocean or bay. A typically productive estuary may not yield many fish after strong rains because of the amount of fresh water that suddenly flows into it, lowering the salinity.

Again, water temperature and oxygen are critical considerations. In the fresh water reaches of a warm estuary, it it possible to find largemouth bass and some panfish. Tarpon, snook, jack crevalle, and striped bass can tolerate fluctuation in salinity. Catfish can also thrive under these conditions. Colder zones may contain salmon, trout, and shad. These anadromous species return from the sea to spawn and often wait in estuaries for ideal conditions.

Areas that have higher salinity provide ideal habitat for redfish, bluefish, seatrout, bonefish, permit and tarpon. Tides, topography, and morphology affect most estuaries, but salinity and temperature are the prime factors in determining the aquatic community in any given sector.

How to Read the Water

Estuaries have current caused by the tides or by the entrance of streams and rivers. Fish orient to the flow of water. Where tidal influences are evident, the fish adjust to the rise and fall of daily tides. Many inland waters are relatively shallow with deeper channels running through them. Gamefish prowling these flats are particularly sensitive to noise and intrusion. A stealthy approach is critical. Boats should be steered around the area to be fished and the engine shut down some distance from where fishing will take place. In some areas a push pole is used to propel boats. Wading is also an excellent technique for reaching fish quietly.

Shorelines and structure often host fish in an estuary and concentrations of food attract gamefish. Fish also take advantage of the tide, moving farther up an estuary or across a flat on incoming water and dropping back on falling tide. Since fish follow definite patterns in many waters, anglers who have learned the routes can take advantage of them.

How to Fish Estuaries and Bays

Estuaries often contain a number of fish species that occupy different niches in the aquatic community. Catching them requires techniques targeted to the particular species sought. A small bait fished on the bottom may entice summer flounder, but striped bass and bluefish would probably ignore it.

First, decide on the species to be caught. Know the habits of the fish and seek the type of habitat most likely to be occupied. The tackle, rig, and bait must then be tailored to the species. In some areas, it is possible to catch several different fish species on the same artificial or natural bait.

Wetlands

Many wetlands generally reflect nearby rivers or lakes. They represent an area of overflow, and gamefish and panfish should be present. Usually, fish invade a wetland during periods of high water, retreating instinctively when water levels drop.

Characteristics

Most wetlands contain bass and panfish. Those in the north contain some pike and pickerel. Catfish and carp may also be present.

How to Read the Water

Wetlands are characteristically shallow, which dictates a quiet approach. Channels in some, make it possible to use a boat. In many wetlands, wading is the accepted method of approaching fish. However, airboats are used in places such as Florida's Everglades.

A wetland should be analyzed the same as a lake, pond, or river. Fish seek out some form of structure and the angler must recognize prime habitat. This could include points, pockets, weedbeds, trees, or a particular type of bottom, among others.

How to Fish Wetlands

Because they are shallow and have a great deal of vegetation, wetlands are difficult to fish. In open spaces, traditional natural baits and lures may be used, but weedless lures such as a spoon or Texas-rigged plastic worm must be used in vegetated areas.

Oceans

Three-quarters of the earth's surface is covered by oceans. These massive bodies of water have many moods, and because of their size, are complex ecosystems. Uninformed people believe that the oceans of the world are endless wells with unlimited numbers of fish ready to be caught. Despite the immensity of the oceans, most of the area is too deep, cold, and lifeless to hold sport or commercial species. Only a relatively small area in the upper reaches of the oceans support fish. Also, loss of habitat and severe fishing pressure, both commercial and recreational, have threatened the existence of a growing number of ocean species.

Characteristics

Water temperature and depth are the two primary factors in determining the aquatic community in any part of the ocean. The waters within a few miles of shore are by far the richest zone and the place where the food chain has its broadest base. The deeper the water, the less food there is to support life. Certain species are pelagic, which means that they roam constantly and do not require specific cover. To survive, pelagic species are dependent on schools of forage fish.

Trying to understand the complexities of an ocean in one lesson borders on the impossible. There are tides with which to contend and ocean currents that run like massive rivers, pulling surface water along with them, and in some areas, creating an upwelling along the sides, providing a productive area for anglers. This upwelling brings nutrient-rich water from the deep to the surface. A warm sun will cause microscopic plants to utilize the nutrients, small animals (zooplankton) eat the plants, fish eat the zooplankton, and the food chain begins, again.

Species Present

The waters off each section of coastline contain several species of fish. More sport species are found in warmer waters than in the colder ones. Ocean fishing is usually extremely seasonal in terms of species with timing being critical to capitalize on the sudden abundance of a species.

How to Read the Water

When water temperatures are tolerable and an adequate food supply is present, marine gamefish appear. They may linger in an area for days, weeks, or months. Ocean species often embark on massive and long-distance migrations.

Those wishing to fish further out in the ocean must board a boat to reach the quarry. At times, schools of fish will be on the surface and vulnerable to anglers who find them. Usually, it is a matter of deciding which species to catch and then in locating favorable conditions. Bottom dwellers orient to rocks, reefs, and soft bottoms, while pelagic species follow forage fish and seek comfortable water temperatures. Obviously, each species has its own habits and habitat.

How to Fish the Ocean

The ocean offers diverse fishing opportunities, ranging from bottom dwellers to species roaming the seas along the edge of the continental shelf. Techniques encompass everything from trolling to drifting or anchoring and methods such as chumming, casting, and live lining.

Newcomers should start with the most abundant species in the area and become proficient. One may easily try other types of fishing once experience is gained. Along most coastal areas, party boats cater to first-timers as well as to veterans. The cost is relatively inexpensive and these boats specialize in locating fish for the customers. Mates on board are more than willing to give instruction and most vessels rent the appropriate tackle.

Deep sea fishing is also very popular. Just a few years ago deep sea fishing was the pleasure of but a few relatively rich people. Today, with modern boats and up-to-date shore facilities, marine sport fishing is a rapidly growing form of angling. As equipment and knowledge of the sea improves, the number of persons seeking their recreation in this manner will doubtless continue to expand. Even though deep sea fishing is still relatively expensive it is extremely challenging and therefore attractive. It takes a great deal of skill to fish at sea. Seamanship of the highest order is required with a knowledge of tides, currents, electronic equipment, heavy fishing tackle, and the habits of marlin, tuna, and/or sharks and other species being basic for success and safety. Many persons who do not wish to invest the sums necessary in their own boats and equipment, charter a boat by themselves or with friends to experience the thrill of deep sea fishing.

LESSON 4

Hooking, Playing and Releasing Fish

LESSON

4

Hooking, Playing and Releasing Fish

Lesson Objectives

Following this lesson students will:

1. Realize that fish strike and fight in different ways.
2. Know effective methods of striking (setting the hook) fish.
3. Be able to land a fish from shore, boat, pier, and jetty.
4. Be aware of the danger presented by some fish with their teeth, spines, and gills.
5. Know how to handle fish in a safe manner.
6. Be able to release fish without harming them.

Materials For The Lesson

1. Photocopies and overhead transparencies of the graphics.
2. A package of large hooks and 3–4 lures.
3. Several hook sharpening devices, including files and hones.
4. One pair of needle-nose pliers for each 3 students.
5. A rod and reel combination with a star drag system. A practice casting plug should be tied onto the line.
6. Several different landing tools to show students—nets, gaffs, and a bridge net to be used from a pier (if they are available in your area).
7. A mounted fish, preferably one with sharp teeth.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	1. Introduce students to the lesson objectives. 2. Begin the lesson by explaining that they will learn several techniques to help them catch a greater percentage of the fish that strike their lure or bait. Many fish are lost due to dull hooks, poor fish fighting techniques, and poor landing methods. Also, fish must be carefully handled to avoid injury to the angler and to the fish. Some fish have very sharp teeth, spines, and gill plates which can cause serious cuts and punctures. Stress that if fish are to be released, that the decision must be made before they are landed. Fish that will be released must be handled very carefully so that they survive. 3. Divide students into groups of three and distribute hooks and needle-nose pliers. Demonstrate the proper method of sharpening a hook by filing both sides of the point and then the bottom to form a very sharp edge. Have the students take turns sharpening a hook and then testing its sharpness on a fingernail. A sharp hook digs into the fingernail while a dull one will slide easily across the fingernail. Demonstrate how to hold the hook with the pliers during the sharpening process. Urge students to sharpen all of their hooks before using them. Even new hooks are usually not very sharp and dull hooks result in lost fish.
II. Hooking, Playing and Fighting Fish A. How to Strike a Fish	4. Discuss how different species of fish strike lures or baits in different ways. Talk about popular species in your area. Some fish will mouth the bait and play around with it. Others will take it immediately and move off with it. Experience is the best teacher here. Ask students to relate their experiences in trying to catch fish and what they have learned.
B. Setting the Hook	5. Setting the hook (striking the fish) begins to bury the hook. This involved pulling the lure toward the angler. Using the overhead transparency and by demonstration, show proper hook setting. The elbows should be kept close to the body and not lifted over the anglers head. Utilize the following steps: (1) have a student stand on the casting plug, (2) move several steps away and face the student, (3) hold the rod at about a 10 o'clock position, (4) pretend that a fish has taken the bait, lower the rod while reeling up the slack in the line, (5) when the rod reaches an 8 o'clock position, quickly snap the rod tip back toward you using primarily your wrists and forearms (remember to keep your elbows near your body), (6) keep the rod slightly bent as you reel

Lesson Content Outline	Classroom Procedure
	in the fish. Explain to the students that it is important to keep the line tight and the rod tip up so that they can control the fish. The only time that slack should appear in the line is when a fish jumps and the slack will prevent the line breaking when the fish shakes its head. Have several of the students demonstrate this technique.
C. How to Play Fish	6. Ask the students if any of them have ever caught a big fish. One that they couldn't just reel in. Lead into a discussion of the fish fighting technique called "pumping." Demonstrate this technique. If necessary, read the attached material for lesson 4 to learn the proper procedure.
	7. Ask students if they know the purpose of the drag on a reel. Using the rod and reel, show them where the star drag is and how it works. Explain that the drag is especially important when fishing for large fish that can possibly break the line or the rod. The drag should be set so that the fish can take line off the reel at no more than 33 percent of the lines rated strength. This may seem very light, but with the rod tip held high, there is still a lot of pressure on the fish and it will tire rapidly.
D. Landing Fish	8. Ask students if they have ever landed a fish and if so, how they did it. Some may have used a net or other tool, but most probably have beached them or lifted small fish from the water to the boat or bank. Discuss proper landing techniques by hand, being careful of teeth, spines, and gill plates; by leading a fish into a net; by beaching only if the fish is to be kept; and by gaffing and tailing.
III. Handling and Releasing Fish A. How to Release a Fish B. How to Hold, Handle, and Unhook Fish	9. Ask students if they have ever released a fish. Disscuss the necessity of handling fish very carefully if they are to be released. If a fish is to be released it is best to keep the fish in the water, carefully removing the hook, and letting the fish swim away. If a fish must be handled, the angler's hands should be wet and the fish handled as little as necessary to remove the hook before placing the fish back in the water. If the hook cannot be removed without hurting the fish, the angler should cut the leader or line as close to the fish's mouth as possible. The hook will rust out in a few days and the fish will not be harmed. After the hook is removed, the fish should be gently placed back into the water, not thrown. Rough handling will damage the slime coating of the fish allowing fungus to develop which will kill the fish.
	10. Using the mounted fish, or if that was not available, with the graphic of a fish, point out the places on a fish that can harm an angler. Point out the mouth, the back spines, and the gill plate. If you have a mounted fish, let the students touch the sharp teeth, the spines, and the gill plates. They can then determine how much damage these can do. Also stress the importance of being extremely careful when removing a lure or hook from a fish. If the fish moves suddenly, the hook could become imbedded in the angler's hand.

INTRODUCTION

Catching fish is what fishing is all about. Catching fish involves hooking, playing and landing. Hooking methods will vary based on the use of different types of lures or bait. Fighting methods also vary since some fish can be easily reeled in and brought to the angler, while others will make long runs, jumps, shake their heads and otherwise try to dislodge the hook. Coping with this is not just a matter of luck, but requires knowledge and skill to easily and efficiently land the fish. Fish can be landed by a number of means: hand, beaching, netting, tailing and gaffing. The best landing method will depend upon on the fishing conditions, fish species and size.

Once fish are landed, they can be kept for food, mounted as a trophy, or released back to their environment. This decision must be made prior to landing the fish, since a fish must be properly handled to have the maximum chance to survive if it is to be released.

Anglers can incur injuries while handling fish. Their teeth, spines, fins, gills and gill plates can all cause cuts or punctures. Each fish differs, and proper handling depends upon knowing the danger intrinsic to each species.

NARRATIVE

Hooking and Fighting Fish

Tackle Considerations

All fishing revolves around catching fish. Catching fish is dependent upon having good tackle, making sure that it is suited for the target species, and keeping it in good repair. Proper tackle consideration involves making sure that the rod is appropriate for the species sought. The line must also be adequate for the lure and rod used, since a light line used with a stiff rod and a heavy lure might break with normal striking force (for that rod and lure).

Hooks must also be sharp. Most anglers agree that the best method of sharpening hooks is to "triangulate" the hook by turning the round profile of the hook point into a triangle with flat sides. To do this, use a sharpening tool (file) to flatten both sides of the hook point at an angle and then flatten the bottom (outside) of the hook point. The result will be a razor sharp hook that will penetrate the fish's mouth easily and quickly.

Detecting Strikes

When bait fishing, fish do not usually strike viciously as often happens with a lure. This does vary with the type of fishing and bait used, however. Bonefish, carp, catfish, sturgeon and suckers may mouth the bait carefully, take the bait immediately, or play with it for a while. Bonefish will often pick up a bait immediately to prevent another fish from getting it. Carp, catfish and suckers will often play with the bait on the bottom. Often a sure pick-up can only be determined when the fish swims off with the bait. Fish that take suspended baits exhibit similar behavior, in that they will often pick at a bait prior to completely taking it.

When trolling bait, fish are more likely to strike solidly to "catch" the bait. Even then, however, it is often necessary to allow a fish slack in the line to completely take the bait and swallow it. This is particularly true in offshore big game trolling.

In some cases, fish treat lures almost as they would a bait by picking at it and taking it only after some examination. This is true of lures such as plastic worms used for largemouth bass, a jig and pork chunk, and various flocked or sponge construction lures. In these cases, experience teaches just how to react to each lure. Many anglers believe that fish should be struck immediately since there is no natural food or bait to keep them taking or tasting the lure. An exception to this is accomplished by some anglers who use the currently popular scents to flavor lures which triggers strikes from fish.

Many strikes from fish do not really require setting the hook since the fish strikes a moving lure and, in essence, impales itself on the hook. In these cases, the fish is immediately detected.

Setting the Hook

Setting the hook is the method by which the hook is buried or forced into the fish's mouth. Striking (setting the hook) involves pulling the lure towards the angler. This can be accomplished two ways. One is to pull on the line as is often done while fly fishing. The second is to move the rod up and back at an angle, much like using a lever, to pull the line towards the angler. The rod can be angled at any position, although most strikes are made with the rod directed up and back. This motion should be made quickly.

Fly fishermen sometimes use just a short sharp pull of the line to set the hook. Other fly fishermen use a short snap of the rod to accomplish the same thing. Most will use both to exert maximum force to sink the hook into the fish. However, too much force will break the line or leader, bend the hook or tear the hook out of soft-mouthed fish. This is also true while fishing with spinning and spincast equipment.

In most cases, one distinct *sharp snap* of the rod is all that is needed to sink the hook if the hooks are sharp. Some situations require more forceful strikes than others. For example, a single very forceful strike is necessary when fishing a plastic worm rigged Texas style (by which the hook is buried into the worm) since the strike must drive the hook through the side of the worm first and then into the fish's mouth. However, striking too hard or repeatedly with a soft-mouthed fish such as a shad, sea trout or crappie can pull the hook through the mouth.

Fighting the Fish

When a fish feels a hook, it struggles to get free. This struggling might involve jumping, making a long run, running back under cover or into obstructions, or swimming around obstacles. Landing the fish involves coping with these challenges by fighting (or playing) the fish, preventing it from getting free.

Each species of fish fights differently. Carp and bonefish are strong, powerful fish that make long runs. Largemouth bass both run and jump. Tuna dive for the bottom. Trout and tarpon go wild when first hooked. Pike and cobia (ling) often come to a boat placidly but become wild at boatside. Fish hooked and played in shallow water are often more likely to jump rapidly, repeatedly and more frantically than those hooked in deep water. Deep water fish often seek the bottom. Very big largemouth bass, over five pounds, are less likely to jump than those of two or three pounds.

It is possible to directly reel in many small fish. They will fight, but this can be overcome with the strength of the line and the action of the rod. However, much of the fun in fishing is gained by using tackle that will allow the fish to fight.

Fighting any but very small fish involves a technique called "pumping". This is a method of gaining line against the power of a big fish so that the fisherman can ultimately land it. The incorrect method of landing big fish is to try to reel or winch the fish to the angler. This is hard to do, can strain the tackle (principally the reel), and is not efficient or quick.

Pumping involves a method of levering the fish in with the rod. To do this, reel until the line is snug and the rod is horizontal, pointed toward the fish. Then raise the rod to a 45 to 60 degree angle to lever or pull in the fish. At this point, rapidly but smoothly lower the rod again, while reeling in the line. Make sure that the rod is not lowered so rapidly that slack develops in the line or that it loops around the rod tip. Once the line is snug and the rod horizontal, repeat the process to gain more line. Many experienced anglers use this method but lever the rod sideways to turn a big fish that is difficult to land. This pumping, combined with the proper use of the drag, allows landing of fish whose weight approaches or exceeds the strength of the line.

Jumping fish can dislodge a hook or lure and get away. Thus, coping with jumping fish is a major problem even though they are fun to catch and watch. Some experienced anglers will even hold their rod tip underwater in an effort to keep the line down and to prevent or discourage the fish from jumping.

Often the best procedure to cope with jumping fish is to immediately lower the rod so that the line is at a low angle, not, in effect, "pulling" the fish up. Another method, sometimes combined with the above, is to push the rod toward the fish when he jumps. This creates slack in the line and prevents sharp impact (strain) on the line as the fish shakes its head.

Most losses with jumping fish occur when using heavy lures such as spoons, heavy plugs, or jigs since these lures will wear a hole in a fish's mouth as the fish shakes its head, and allowing the fish to toss the lure free. The loss of jumping fish is often not the fault of the angler, regardless of the action taken.

Understanding Drag and Drag Systems to Fight Fish

All reels have built-in drags. The more sophisticated can be found on boat, spinning and bait casting reels, but spincast and fly reels also have drags. A drag is nothing more than a brake which creates resistance to the line going out when a fish makes a run. Most drags work by creating pressure between soft and hard drag washers in the reel, which are alternately keyed to the spool and the shaft. Many anglers seeking small fish or fish that can be easily pulled in without fear of breaking the line do not use the drag and even tighten it to prevent slipping. It is necessary to use the drag system when fishing for any fish that might break the line or rod.

Drag must be set properly for the reel and the line. Generally, drag should be set to approximately 1/5 to 1/3 of the pound test of the line. One of the reasons for this seemingly light drag setting is that drag or resistance against the fish is not only a function of the drag built into the reel, but also of the angle of the rod, the amount of line in the water, and the resulting water resistance on the line. A high rod angle and much line out creates more drag against the fish.

A lightly set drag can serve as insurance against a broken line, and drag can be increased by hand or finger pressure on the spool of the reel. Bait casting anglers often use thumb pressure on the spool, spinning and fly anglers increase drag with finger pressure on the spool rim, and spincast anglers can squeeze the line lightly to increase drag.

Cupping of the reel and reel spool is usually accompanied by raising the rod in pumping a fish since the pressure can be released immediately with the rod dropped to horizontal to prevent line breakage. Drag must also be loosened when a big fish is ready to land as the short line out at this point provides little shock absorbency.

Landing Fish

Fish can be landed by hand or with tools made for that purpose. These tools include nets, gaffs and tailers. Nets are most commonly used for landing fish and vary in several ways. For boat or shore fishing, long handled nets are used while short handled nets are adequate for stream fishing. The size of the net will vary based on the size of fish expected to be caught. Some specialty nets are also available, including circular no handle nets on a long rope used for pier, bridge and jetty fishing.

Size makes a big difference in landing any fish. Small species such as sunfish, small bass, small catfish, croaker, spots, snappers, trout and similar species can usually be landed by hoisting the fish out of the water with the rod and depositing it on the boat, bank or pier. Care must be taken when doing this with soft-mouthed fish, when fishing with small, light wire hooks which might bend, or when using light line.

When landing any large fish, first back off (loosen) the drag since a quick erratic run by the fish might otherwise break the line. When boat fishing, large fish will sometimes try to run under the boat or around propellers. For this reason, be sure that the fish is tired out. Fish that are to be released should not be completely exhausted since this makes recovery far more difficult. Landing by net, gaff, or hand is then possible with nets and gaffs being more popular for most boat fishing.

When fishing from the shore, beaching is a popular way to secure fish. Since beaching will damage the slime coating on the fish, it should be done only if the fish will be kept. To beach a fish, lead it into increasingly shallower water, gradually sliding the fish onto dry land on its side. Once on dry land, or in the very shallow water, the fish can be lifted by the gills and the hook removed.

When hand-landing the fish, the fish can be grabbed by the gills (being careful of the hook or hooks in and around the mouth), by the body (under the belly), or by the tail (at the wrist of the tail) with those species with a strong finned tail that will not collapse as the fish is lifted.

When landing bass by the mouth, a popular way is to use a thumb and index finger to grip the fish by the lower jaw, but due care must be taken of hooks, together with the size and strength of the fish. This procedure immobilizes the fish temporarily and makes removing the hook much easier.

Netting a fish does require a certain technique, regardless of whether it is done from a boat or shore. First, the fish must be under control of the angler as much as possible. Next, the fish must be led alongside the shore or boat. The net should be placed in the water and the fish led head first into the partially submerged net. Then if the net touches the fish, the swimming movement of the fish will drive it into the net, not out of the net as will occur if the fish is netted tail first. Once the fish is completely in the net, the net must be raised. With heavy fish, also grab the rim of the net to prevent strain on the net frame.

Fish to be gaffed are usually large and difficult to net. Once the fish is under control, it must be led to the landing area and the gaff placed so that the hook will hit the fish just off center of its body weight. Very large fish should be hit in the muscular body, while smaller fish can be hit anywhere, including the stomach area.

Gaffs are large usually barbless hooks on long handles used to hook fish at the boat or on shore in order to land them and prevent them from breaking the line and escaping. Gaffs are typically described by the hook size (distance across the point and shank) and the handle length. Specialty gaffs include lipping gaffs, a small gaff with a two to three inch hook on a very short handle used as a hand gaff for lipping fish such as tarpon.

Except for those fish lip-gaffed to remove a hook, lure or fly (such as is common with big tarpon), gaffs should only be used if the fish is to be kept for food or a trophy. A gaffed fish which is released will die even if it appears lively at the time of release.

Tailers are primarily used by salmon fishermen since these fish have a thin but strong "wrist" at the tail that allows using a noose on the fish for landing. Since these can damage the fish, they are usually only used if the fish is definitely to be kept.

Some specialized landing techniques are used for fishing from a high bridge, jetty or pier. In these cases, so-called "bridge gaffs or bridge nets" are used to land fish that are many feet below the anglers and impossible to reel in. Bridge nets have a circular rim supported at three points around the rim and tied to a single rope. Bridge gaffs are similar, but consist of three or four prong sharp grappling hooks on a single rope. In all cases, these devices are lowered to the water, submerged, and after the fish is led over the net or gaff, the gaff or net is raised to secure the fish. Once the fish is landed, it should be unhooked and immediately placed on ice.

Handling and Releasing Fish

Except for those fish released in the water by removing the hook or cutting the leader, fish must be handled. In all cases, the least rough handling is best.

All fish are caught on hooks, so due care must be used when handling freshly caught fish, particularly those taken on multiple hook lures, in which some hooks are free swinging. Also, teeth, gills, and fins can puncture or cut. Fish such as walleye, bluefish, snappers, pike, and barracuda have sharp teeth which must be avoided. Even fish such as trout and bass have small teeth which can cause abrasions if handled improperly.

Snook and other species have sharp gills and gill plates which can cause bad cuts. Catfish are known for their sharp spines in the dorsal and pectoral fins, but other fish also have sharp spines that can cause puncture wounds and infections. It is vital to know the fish being sought to avoid contact with such areas and to prevent accidents.

Fish to be released should be held as little as possible. The best release is to keep the fish underwater, using the hand or pliers, to remove the hook or lure from it's mouth. An excellent solution for larger fish or those fish that have taken a bait deeply so that the hook cannot be easily removed is to cut the leader close to the fish's mouth. In most cases, the hook will rust out (the acids and enzymes in a fish's gill tract being a major factor) and cause the fish no problem.

If the fish must be taken from the water, use a wet hand or wet rag, holding the fish firmly but gently to remove the hook, and replace the fish back in the water as rapidly as possible. Never throw a fish back into the water. Instead, gently place it in the water, and if necessary, move it back and forth with care to restore oxygen to its gills until it is ready to swim away. Release fish in shallow water so that they can recover before swimming in open water or fighting a current.

LESSON 5

Care, Preparation and Cooking of the Catch

LESSON
5

Care, Preparation and Cooking of the Catch

Lesson Objectives

Following this lesson students will:

1. Understand how to store fish properly and how this varies with the species.
2. Be aware of safe methods of using knives to clean fish.
3. Know several methods of cleaning fish.
4. Know how to cook fish.
5. Know several methods of preserving fish.
6. Be aware of potential toxic substances in fish.

Materials for the Lesson

The materials needed for this lesson will vary depending upon how involved you wish to become. It can be taught in a classroom setting without any "hands on" type of involvement by students, or you can conduct the class in a situation with the students actually cleaning fish, cooking and eating them. All of the materials below will be needed for the latter of these procedures, along with an appropriate setting such as someone's home or a park with some type of cooking facility. Assistants to help with the cleaning and cooking of the fish would be advisable.

1. Several fish of different species that can be scaled, skinned, and filleted.
2. Several fish cleaning items including fillet and butcher knives, scalers, pliers, cleaning boards with clamps, or boards for cleaning and a hammer and nails.
3. An ice chest with the fish kept fresh in it.
4. Cooking items: tin foil, skillets, cooking oil, flour, corn meal, etc.
5. Eating utensils and dishes.
6. Photocopies of the fish cleaning graphics in the appendix and overhead transparencies of the same if the lesson will be conducted in a regular classroom. Photocopies of recipes in content of lesson.

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TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	1. Introduce students to the lesson objectives.
II. Handling the Catch A. Live Wells and Stringers B. Storage on Ice C. Field Dressing	2. Explain that this lesson focuses on what to do with the fish after it is caught until it is served as a tasty, nutritious meal or saved to eat another day. Most fresh water fish will keep well on stringers or in live wells. However, if they die they should be field dressed or placed on ice. Most salt water species must be kept on ice to preserve their freshness. The melting water from the ice must be drained away since the ice water will affect the quality and taste of the fish. 3. Field dressing involves removing the gills and entrails of the fish. These parts spoil most rapidly and can affect the taste of the fish if they are not removed. After removal, the fish should be thoroughly rinsed, wrapped in damp rags (the evaporation will help cool them), or preferably placed in a plastic bag on ice.
III. Methods of Cleaning Fish A. Skinning B. Scaling C. Filleting D. Steaking	4. Ask if anyone has cleaned a fish, and if so, what they did. Explain that there are several ways to clean fish and that the method used can vary with the size and the species of fish. For example, bluegills are often scaled and catfish are skinned and both are eaten whole and removing the bones after cooking. However, both species may also be filleted, which removes the bones before cooking. Big fish are often steaked, but many are also filleted and cut into individual portions. The angler has the choice of cleaning method. 5. Demonstrate how to properly clean a fish by scaling, skinning, and filleting. Stress the importance of safe handling of the knife by both discussion and demonstration. Then divide the class into groups of 2–3 students, each with an assistant, and let them clean their own fish, with the assistants helping as needed. Cleaning gloves used here will help avoid cuts.
IV. Storing Fish A. Refrigeration B. Icing C. Freezing D. Other Methods 1. Smoking 2. Pickling 3. Canning	6. After each student has cleaned a fish, discuss methods of storing the fish if it is not to be promptly eaten. Discuss icing, refrigeration, and freezing. With older or advanced students introduce smoking, pickling, and canning. Review the lesson content if you require additional information on these procedures. 7. Tell the students that they are now going to cook the fish that they have cleaned. Explain that there are numerous ways to cook fish including frying, broiling, grilling, baking, poaching, and microwaving. However, today you are going to fry the fish using

Lesson Content Outline

- V. **Preparation**
  - A. Cooking Methods
    - 1. Frying
    - 2. Broiling
    - 3. Grilling
    - 4. Baking
    - 5. Poaching
  - B. Recipes
- VI. **Toxins and Fish Diseases**

Classroom Procedure

either flour, crumbs, or some other breading, or batter, and frying in cooking oil. Let each student choose the type of coating desired.

8. Have the students get their fish and with their assistant prepare the fish with the appropriate coating. Again, stress safety with the frying pans and hot oil, and let the students prepare their fish.
9. After cooking, let the students eat their fish, sharing with others whose was cooked with a different coating.
10. Briefly discuss the potential problem of fish contamination due to the area where it was caught or with the species of fish. There are restrictions on eating fish from some areas of water and certain species from these areas. Students should be encouraged to investigate any particular problems that may exist before eating the fish and be aware of any warnings posted in areas where they fish. The Conservation department can also warn of any potential danger.
11. The students should be encouraged to assist in clean up, both the areas where the fish were cleaned and the pans, etc., necessary for cooking and eating the fish. Explain that fish entrails and carcasses attract flies and other insects and smell badly, and they should be buried or placed in tightly sealed plastic bags and disposed of in trash containers.

INTRODUCTION

One of the great joys of any successful fishing trip comes in eating the catch. Fish are delicious, offer a change in the diet, are increasingly noted by doctors and nutritionists as a healthy alternative to other foods, and are ideal for those on low budgets, low cholesterol, or low calorie diets. When properly cared for from the time they are caught, cleaned, and cooked, fish are excellent eating.

Unlike other food, fish do require special, but not difficult or extraordinary handling. This special handling begins when the fish is caught, and continues through cleaning, storage, cooking and serving. Every household has the tools and storage facilities for handling fish. Hence, fish can be a staple food and served on a regular basis. Virtually all sport fish are suitable for eating.

NARRATIVE

Handling the Catch

Fish are a valuable resource. If they are not used for food or for the occasional trophy mount, they should be returned to the water promptly. To release fish, use pliers or fingers to remove hooks from the fish's mouth while it is still in the water. As a result, the fish does not have to be touched or brought into the boat. Fish that are handled or allowed to lay on a boat deck, pier, jetty or shore will loose their protective slime coating, severely decreasing their ability to survive.

Fish that have to be removed from the water for release should be handled firmly but gently. Hands should be wet to protect the fish's mucous covering. Do not lift fish by the gills, by the eyes (as is sometimes seen with pike), or with a gaff on the body of the fish. However, some fish might have to be lip gaffed to remove hooks.

Fish that are to be used for food must be kept fresh until they are cooked, frozen or otherwise stored. Keeping fish on a stringer, in an aerated livewell, on ice as whole fish, or cleaned and on ice will keep them fresh. Dead fish should immediately be placed on ice.

If the fish can not be kept on ice or on a stringer (as in stream trout fishing), field dressing is a must. To field dress, remove the entrails and gills, which are the first areas to spoil. If these are not removed, the whole fish can spoil.

When field dressing a fish, use a sharp knife to completely remove all the gills. Then insert the knife into the vent of the fish and run the blade up along the belly to the head. Keep the knife blade shallow so as to keep from puncturing the intestines. Once the body cavity is completely open, remove all the entrails. Some fish, such as trout, have the kidney along the body wall, below to the backbone. Remove this with a spoon or with your thumbnail.

Field dressed fish are best kept by keeping the body cavity open with ferns or grass. If practicing this type of storage, use an insulated bag, insulated creel or fishing vest with an insulated pocket to protect the fish from heat. Damp rags are ideal for a wrapping since evaporation helps to cool the fish.

To store fish on ice, field dress them, keep them whole, or fillet them. Be sure to have enough ice for the fish and to drain the water from the melting ice. Contact with ice water will adversely affect the quality and taste of the fish.

Various fish species keep differently. Trout and salmon species often keep very well when field dressed. Most fresh water species keep well on a stringer or in a livewell. However, if they die, they should immediately be placed on ice or field dressed. Most salt water fish will not keep well when field dressed, on a stringer or in a livewell, and must be kept on ice to preserve their freshness.

Methods of Cleaning Fish

Skinning

Removing the skin of many fish also removes fatty tissue which can contribute to a muddy or cloudy taste. How one skins a fish depends upon the species. Most fish are skinned when they are filleted, but some are skinned as they are cleaned. Catfish are easily skinned and cleaned at the same time by nailing the head to a board or securing it in a clamp. Once the fish is secured, cut through the skin around the head. Then use pliers to pull the skin from the body, pulling toward the tail. Grasp the fish with two hands, break the backbone at the head and pull the entrails and head away from the skinned body. After washing, the fish is ready for cooking, and the bones are removed after cooking.

Scaling

Fish to be scaled are not skinned. Scaled fish are cooked with the bones in the body. The bones are removed after cooking. To scale a fish, hold the fish by the tail and pull or push the scaler towards the head. Do this repeatedly over both sides of the fish until all scales are removed. Since the fish will be cooked with the skin on, remove the head (with all gills), all fins, and the entrails.

Scalers range from simple home made devices, such as old time bottle caps (non-screw off) nailed to a board, to plow-shaped devices that will not scatter scales, to serrated rack-like hand tools. Smaller fish such as panfish are usually scaled. However, they can be filleted, even though this is a difficult process. Larger fish are usually filleted. Species such as striped bass, largemouth and smallmouth bass, sea trout, walleye, white bass, salmon, and pike are typically filleted. Since the filleting removes the skin and scales, scaling is not necessary.

Filleting

Filleted fish have all the bones and skin removed before cooking. The final result is two fillets—one from each side—that are the meaty portion of the fish. There are two methods of filleting any fish. One is to remove the fillets from the fish by working the knife around the rib bones, while the other is to cut through the rib bones which are removed later.

Special knives are required for filleting. These are long and thin, tapered so that they are springy and flexible. They must be surgically sharp.

To fillet a fish, begin by laying the fish on its side. Make a sharp vertical cut down to the bone (vertebrae) just in back of the gill plate and pectoral fin. Make a second cut along the backbone, from head to tail, cutting down to the backbone (ribcage) and keeping the knife blade on the same side of the fish as the original cut.

Continue to cut down parallel to the dorsal fin until to the backbone, working all the way to the tail. At this point, spread the cut open and work the blade around and over the rib bones which protect the body cavity. Work to the belly and then cut back to the tail. Do not cut the fillet free from the tail. Flip the fillet over so that it is flesh up and skin down. Using the tail for a grip (which is why you do not remove it), work the fillet knife between the skin and flesh.

The secret to skinning the fillet is to pull on the skin (tail) while using a firm sawing motion with the knife blade. Once the skin is free, quickly wash the fillet in cold water, store on ice or freeze and repeat on the other side. For fish which do not have a strong tasting skin, skin removal is not necessary.

An alternative method involves the same basic procedure. However, in this case cut through the ribs during the cut along the backbone, making the removal of the fillet far easier. To complete the fillet, use the knife to carefully carve out the rib bones.

Steaking

Steaking is a method of cutting large fish across the body into steaks or very large fish into manageable chunks. First the fish must be scaled (or skinned) and cleaned as above. Usually fish are scaled only if the scales will interfere with the cutting and steaking process. Then cut into pieces suitable for cooking. For most fish, cut steaks through the body working from the tail to the head since the head provides a "handle" of sorts. Make the steaks a suitable thickness for one serving, usually 1/2 to 1 inch. After steaking, trim away any belly fat or obvious bones, but not the vertebrae.

Very large fish can be treated the same way, by cutting the large steaks into smaller individual portions. To make steaking easy, chill the fish or place it in a freezer until it is partially stiffened. Cleaner neater steaks will result. *NOTE*—Sharp knives must be used to clean fish. Safe knife handling must be used in all cleaning operations. For this, make sure that the knife is suitable for the task. Use heavy, thick-bladed knives for steaking. Use thin, flexible knives for filleting. Make sure that the filleting blade is as long or longer than the width (dorsal to ventral) of the fish. Wash any slime from hands or the knife handle to prevent slippage. Keep hands in back of the blade at all times. As an extra precaution in handling slippery fish, some anglers are now using metal mesh reinforced gloves to protect themselves in case of an accidental slip of the blade.

Storing Fish

Fish must be kept alive or chilled from the time they are caught until they are properly stored. Cleaning should be done as soon as possible to preserve maximum flavor, although properly iced or chilled fish can be kept for up to a day before cleaning. After the fish are cleaned, filleted, steaked or skinned, there are several storage methods possible.

Refrigeration

Fish can be refrigerated for up to two days, although there are variables that will affect this time period. Large fish or large pieces of fish can be refrigerated longer than small pieces. Lean fish will store better than fatty fish.

To refrigerate fish, wash under cold water and dry with paper towels, then wrap with plastic wrap, waxed paper or aluminum foil.

Icing

Fish can be iced either whole or after they are cleaned. Icing is the best method to use when transporting fish. Use a good quality insulated cooler. If possible, leave the drain open so that melting ice water will drain. Keep the fish on a rack or at least above the melting ice.

Freezing

Frozen fish will last from one to six months, depending upon the type of fish (lean or fatty), size of fish, freezer temperature, and wrapping and preparation methods. The cause of much poor tasting frozen fish is due to improper wrapping. As a result, air contact with the fish causes a dry, reddish "freezer burn."

To prevent freezer burn, wrap the fish in plastic wrap or aluminum foil, then over wrap with freezer paper.

An alternative procedure is to freeze the fish in a block of ice. Standard waxed milk cartons or plastic refrigerator containers are ideal. Drop the fish into the carton, leaving room for the fish to be surrounded by ice. Fill the carton with water. Close and freeze immediately.

Another method is to freeze the fish, remove from the freezer and dip in ice water several times to build up a coating of ice. Then wrap tightly in freezer paper and place in freezer.

To thaw frozen fish, place in a refrigerator overnight. Do not allow fish to thaw at room temperature.

Other Methods

There are other methods by which fish can be stored; most involve some form of processing which also cooks the fish or otherwise makes it edible. Smokers are readily available, complete with directions and wood chips for hot smoking fish. Smoked fish is ready to eat and can be refrigerated for up to several weeks.

Pickling is a method of preparation involving brine or lime solutions. The result is a preserved edible fish that can be kept refrigerated for up to two months (usually two weeks for the lime prepared fish). The freshly cleaned and chunked fish is preserved by the pickling solution in which it is stored. Pickled fish can be used in casseroles, as a garnish to a main dish, or as a snack or hors d'oeuvres.

Canning will preserve fish for a year and allows a ready supply of fish long after the season or when more fish are kept than can be conveniently used fresh or frozen. To can, use standard canning procedures and pressure cooker processing. Canned fish are often used for casseroles, stews, chowders, appetizers, and salads since the fish is in chunk form and already cooked.

Preparation (Cooking) Methods

Most fish is cooked fresh or from frozen packets. Cooking methods include:

Frying

Most fish are pan fried. Pan frying is nothing more than cooking the fish briefly on both sides in hot oil (hot enough to sizzle when a drop of water is dropped in the pan). Pan fried fish can be coated as desired with flour, breading, or batter. Batter formulas include everything from a pancake type batter to those prepared with spices or beer. Both cleaned fish and filleted fish are typically used in pan frying.

Deep frying involves slipping the fish gently into a deep pan filled with hot cooking oil. The fish can be fillets or cleaned small fish, with or without batter. Batter dipped fish are most often used.

Broiling

Broiling fish under the heat of an oven boiler is a rapid method of cooking small fish or fillets. Usually only several minutes on each side are required.

Broiling uses a high heat above the fish, with the fish turned over half way through the cooking. The high heat can dry some fish, so basting with butter, cooking oil, lemon-butter or other sauces helps to keep the fish moist and tender.

Grilling

Grilling involves cooking the fish on a grill, usually an outdoor barbeque grill. As with broiling, a high heat, short time period and rapid cooking is standard. Fillets, steaks or cleaned whole fish can be grilled. To grill, set the grill to a high heat, place the fish on the grill, baste frequently and turn over when almost done to grill the other side. Fillets, steaks or whole cleaned fish are grilled, but thick portions are best to keep the fish from falling apart when turned over. The fish will cook rapidly and can be checked by separating the flesh. It should be white and flaky, but not dry and brittle.

Baking

Baking is best for preparing large fish and also helps prevent drying out the lean fish. Baking involves basting the fish with natural juices, butter, cooking oil or sauces, and cooking in a covered pan under moderate heat. Cooking times for baked fish are longer than for pan fried, broiled or grilled fish, usually about 20 to 30 minutes. Excellent variations of baked fish are possible using various sauces and bastings made of soups, marinades, and lemon-butter-herb combinations.

Poaching

Poaching is an excellent method of cooking large whole fish and preserves their delicate flavor without drying. Special poaching pans (elongated lidded pans) are made for this. The whole cleaned fish with the head usually left on is placed on a rack usually supplied with the pan, and covered with a light vegetable or herb spiced broth. The fish is cooked in this broth until done.

Simmering is similar to poaching, although it uses a higher heat and a more rolling boil to the liquid. As a result, cooking time is shorter. Since it is cooked in a broth, the cooking time is not as critical as for other cooking methods.

Steaming is a similar method, often confused with poaching, in which a liquid is under the fish, cooking the fish only by the steam emiting from the liquid. Most poaching and steaming cooking times are about 15 minutes. To prevent poached, simmered and steamed fish from breaking up when removed from the pan, place the fish in a cheese cloth wrapper.

Recipes

Recipes for cooking fish are many and varied and can be found in numerous cook books, many specifically written for fish and seafood. Fish recipes number in the thousands, but some simple, easy to follow suggestions include:

PAN FRIED FISH—Required—lean dressed whole fish, 1/2 cup milk, one egg, 1/2 cup flour, seasoned with salt, pepper and any special herbs, sufficient cooking oil, margarine or butter for covering pan surface to a depth of 1/8–1/4 inch, one lemon, parsley.

Mix egg and milk. Dip fish into egg/milk mixture, coat with flour. Place butter or oil in cooking pan and raise to high heat. When a drop of water sizzles, drop in fish. Cook until brown on one side, turn over and cook an equal length of time. Remove from pan onto paper towel to drain, place on serving platter, cover with lemon juice and parsley.

For a variation of this, use a heavier, breaded coating or batter. Various sauces of lemon/butter/herbs are also tasty as a garnish for the finished fish.

Broiled Fish

Required—fish fillets, salt, paprika, chicken stock (broth) (or bouillon cubes), lemon juice and butter. Coat the baking pan with butter or oil and sprinkle with salt. Heat pan in oven. Remove pan from oven and place fish on the hot pan. Sprinkle fish with salt and paprika. Heat fish under broiler for three minutes, remove from heat, add broth (chicken stock) over fish and return to oven for 10 to 15 minutes. Add lemon juice or lemon-butter juice over fish just before serving.

The above recipe is ideal for broiling since broiling gives the dish the unique broiled taste, while the broth (chicken stock) preserves the moistness of the fish and adds to the flavor. Preventing broiled fish from drying excessively is one problem with this cooking method. Similar recipes call for heavier, thicker additions of soups, salad dressing, sauces, and vegetables.

Grilled Fish

Grilled fish are simple to cook, but one must watch the grill. For this recipe, use steaked fish, whole small fish, or large thick fillets. Clean the grill thoroughly and coat with cooking oil or Pam. When the grill is hot, coat both sides of the fish with a thin layer of a favorite barbeque sauce (chicken flavor only) or with lemon-butter sauce, and place immediately on the grill. Coat the top side of the fish with sauce as needed. Turn after the fish appears done and grill to a brown on the opposite side. Coat again as needed with sauce. Remove when done, usually about 15 minutes cooking time.

For variations of this recipe, the fish can be previously soaked in wine, sauce, salad dressing or lemon marinade for several hours. Consult cook books for other recipes.

Baked Fish

This recipe will work for many fish, using several different sauces. Large fish are best, such as steaked fish, thick whole cleaned fish, canned fish, large fish chunks, or thick fillets. Place the fish in a baking pan. Cover with one to two cups of sour cream, salad dressing, or a thick vegetable stew. Add salt and pepper to taste. Cover, and place in a baking oven for 20 to 30 minutes.

Poached Fish

Ideal for trout, salmon, walleye, pike. Wrap whole fish (cleaned but head attached) in cheese cloth, leaving enough at both ends for a handle. Fill poaching pan with water and a light assortment of small onion quarters, slices of carrot, parsley, bay leaf, salt, and pepper. Bring to a boil and add fish, making sure that the fish is completely submerged. Cooking time is about 10 minutes for most fish.

Other Recipes

Other recipes that go well with fish include sauces, garnishes, salads, soups, breads, and appetizers. Most cookbooks contain recipes related to fish dishes.

NOTE—Different fish species differ in flavor. Crappie, trout, flounder and sole have a light delicate taste and are best when not heavily breaded or cooked with heavy sauces. Bluefish, bass, pike and walleye have a stronger fish taste which often goes well with sauces.

Leftovers

Leftovers should be stored immediately after the meal, either in the refrigerator if they are to be eaten within 24 hours or in the freezer if freezing is possible, and then eaten within a short time. Some dishes, such as casseroles, stews and chowders might require slightly different handling. Check good cookbooks for specific directions.

Toxins and Fish Caused Diseases

An angler should be knowledgeable about the fish caught and of any particular pollution problem associated with the species or the fishing area. Currently, over half of the states have some fish consumption advisory restrictions due to toxic contamination. Often this is in localized waterways. Currently, the most severe problems are in the state of New York and the Great

Lakes. Since anglers are not protected by the safeguards which monitor toxins in commercial fish catches, it is important to be aware of these advisories and of locally posted warning signs.

Presently, PCB's, DDT and chlordane are the most pressing problems, although fish can become poisoned through halogenated hydrocarbons (PCB, DDT, dieldrin, PBB), heavy metals (mercury, lead and cadmium), and radionuclides (radio active atoms such as strontium—90). Sources of contamination include direct chemical or metal spills, runoff from ground and surface water, and air carried contaminents.

Special cleaning methods can be used when catching fish from areas of hydrocarbon poisoning. These include skinning instead of scaling and removing fatty areas, such as the flesh around the backbone, along the lateral line (side), and from the belly.

Allowable contaminent levels are set based on the average consumption of fish by people and the knowledge that in people, as with fish, these poisons do build up in the tissue and do not metabolize out in time.

One poison increasingly becoming a problem is found primarily in fish from tropical areas. Ciguterra poisoning builds up in the flesh of reef living fish. Reef fish get this in their system by eating organisms that are toxic to man, even though not to these fish. The toxins are found in higher concentrations in the larger species such as barracuda but can be found in as many as 600 tropical and reef living species, including the popular yellowfin, grouper, and amberjack. Symptoms of ciguterra poisoning include tingling of the lips, tongue and mouth, numbness, nausea, cramps, vomiting, diarrhea, weakness, muscular pain, blurred vision, partial blindness, skin blisters and a rash. Mortality rate is less than 10 percent, but recovery is slow.

Check reliable sources if any type of poisoning is suspected in tropical fish, check when fishing around industrial or chemical plants, and do not eat any questionable fish.

LESSON 6

Personal Fishing Safety

LESSON
6
Personal Fishing Safety

Lesson Objectives

Following this lesson students will:

1. Understand that fishing is not a dangerous sport, but safety must be considered at all times.
2. Know how to dress properly for outdoor fishing situations.
3. Understand the types and uses of PFD's.
4. Be aware of the problems involving insects, poisonous plants, and the sun, and how to prevent or treat them.
5. Understand the potential dangers of storms, lightning and flooding.
6. Know how to use a boat in life saving.
7. Understand the dangers, causes and first aid for hypothermia.
8. Know basic first aid procedures for outdoor mishaps.

Materials for the Lesson

This would be a good lesson to involve outside speakers. With the wide variety of outdoor clothing and PFD's available, the local sporting goods dealer may be invited to speak about appropriate outdoor clothing for different situations. A nurse, M.D., or representative of the Red Cross could talk about basic first aid, hypothermia, and treatment for sunburn and insect bites. This would leave you with the responsibility for "setting the stage" with a brief discussion on being safety conscious at all times.

1. Clothing samples for hot, cold, and wet outdoor activities.
2. Several types of boots, waders, and hip waders, and a belt to use with waders.
3. Insect repellents, sun blockers, sea sick pills, sun glasses.
4. Several different types of PFD's.
5. An orange, large hook, and loop of string for hook removal demonstration.
6. First aid kit.
7. Photocopies and overhead transparencies of graphics from the appendix.

TEACHING STRATEGY

Lesson Content Outline

I. Introduction

II. Clothing and Protection
- A. Clothing
  - 1. Body Clothing
  - 2. Caps and Hats
  - 3. Gloves
  - 4. Boots and Footwear
  - 5. Rain Gear
- B. Protective Gear
  - 1. Sun Glasses
  - 2. Insect Repellent
  - 3. Sun Blockers
  - 4. Sea Sick Prevention
  - 5. Ice Fishing Gear

III. Weather Considerations
- A. Lightning
- B. Wind and Storms
- C. Flash Floods, Reservoir Releases, Low Dams

IV. Safety Around Water
- A. Wading
- B. PFD's
- C. Swimming
- D. Reach-throw-row-go
- E. Hypothermia

V. Basic First Aid
- A. Hook Removal
- B. Cuts and Bleeding
- C. Sunburn and Insect Bites
- D. Other Medical Problems

Classroom Procedure

1. Introduce students to the lesson objectives.
2. Introduce your guest speakers to the students and indicate the topics they each will cover.
3. Lead a brief classroom discussion on the need for thinking "safety" at all times, especially when in the out-of-doors. Topics to mention will vary by geographic location, but can include: a) weather considerations including lightning, wind storms, cold, and heat, b) use of PFD's, c) reservoir releases and low dams in rivers, d) safe wading, e) insects, f) sun glare, and g) fishing with a partner.
4. Introduce the sporting goods dealer who will demonstrate clothing, caps, gloves, boots, PFD's, rain gear, waders, etc. He should be instructed to discuss layering clothing, clothing for special situations, safe wading, PFD's for different purposes, and protection from the elements including sun and rain. He/she might also relate some "real-life" situations and how they were dealt with. The various types of materials the clothing is constructed with and its advantages and disadvantages should also be included. Students should be allowed to touch the various garments.
5. Introduce the medical or Red Cross representative to discuss basic first aid and hypothermia. This individual should talk about hook removal techniques including when and when not to attempt hook removal, how to treat minor cuts and other injuries and when to seek medical attention, how to recognize hypothermia and what to do about it immediately and to encourage medical assistance if it is available. If the representative is from the Red Cross, he/she could also discuss life saving techniques and the reach, throw, row, go concept.
6. Conclude the class by emphasizing the importance of thinking "safety."

INTRODUCTION

Fishing is not a dangerous sport, but certain precautions must be taken both to avoid dangers and to enjoy this popular outdoor sport. Use clothing designed for the outdoors to cope with heat, cold and inclement conditions.

Proper protection is also suggested for avoiding sunburn, insect bites, sun glare, sea sickness, and rain. Ice fishing requires warmer clothing and footwear for the fishing conditions and must be carefully planned.

Weather is a big consideration for any sportsman and especially so for fisherman. Lightning, storms, high water and fishing below dams can present real dangers. Knowing about these dangers and how to avoid them are necessary for safe fishing.

Safety around water involves wearing and being knowledgeable about personal flotation devices (PFD's) when fishing from boats or in certain wading situations. Swimming skills are helpful and proper life saving procedures should be known and practiced. One major, yet seldom realized, danger is hypothermia. Hypothermia can occur even during mild weather.

First aid is an important skill for everyone, and anglers should be especially versed in proper action for embedded hooks, cuts, and other first aid problems, including sunburn and insect and snake bites.

NARRATIVE

Clothing

Clothing will protect from injury, insulate to preserve body heat in cold weather, provide a method of cooling in hot weather and keep anglers from getting wet and chilled in inclement weather. While ordinary clothing will serve for fishing, it should be serviceable and sturdy. Because the dangers of skin cancer from prolonged exposure to the sun are becoming increasingly apparent, complete coverage is recommended, especially when fishing during the summer or in tropical areas. Long pants and long sleeve shirts can be rolled up if desired for short periods, but short pants and short sleeve shirts cannot provide complete protection.

For summer or hot climates, lightweight clothing is best, in light colors that will reflect the heat, unless the fishing conditions require camouflaged or dark clothing to keep the fish from spotting the angler. Even in warm climates, carry an extra jacket, sweater or rain parka. Often fishing trips begin early in the morning when it is still chilly and end late in the evening when it again becomes chilly—regardless of the heat of midday.

For fishing in cold weather, experienced anglers agree that layering is the best protection since layers of clothing can be added or taken off as required. For very cold weather, long wool or synthetic underwear helps to maintain body heat as will wool shirts and warm pants. Additional layering can include shirts, sweaters, down or synthetic vests, or jackets, all covered with a rain parka. Rain parkas are good not only for inclement weather, but also for retaining heat, especially on windy days. For extreme cold a one-piece heavy insulated snowmobile suit is ideal.

Caps and hats prevent loss of body heat (estimates indicate up to 30 percent of body heat is lost through the head/neck area), and protection from glare from the water and from overhead sun. Head wear depends upon the type of fishing. In western areas, western style hats provide good protection from glare and sunburn. Baseball style caps are ideal. They are lightweight, can shield the head from the sun, and have a bill to protect the eyes from glare. The best hats of this type are light colored to reflect heat. Balding men should avoid the popular mesh style caps in summer since these will allow severe sunburn of the scalp. The best bills are those with dark underbrims to minimize glare from the water. Some salt water light tackle anglers in tropical areas (Florida, Gulf Coast) are using "Lawrence of Arabia style" back flaps on these caps to prevent neck sunburn.

Hats or caps for winter should be capable of protecting large areas of the head, including the ears. Good choices are down or synthetic insulated caps or hats and the wool roll down knit Navy-style "watch cap". Knit dickies are also good as neck protection in winter.

Gloves—Angling and cold weather seem almost incompatible when it comes to hand protection. However, there are gloves that allow the fisherman to tie knots, handle tackle, hold line for casting and spinning, and to land fish. Good choices include the light weight plastic or rubber gloves or hunters gloves that have flaps for exposing fingers. Also good are anglers gloves that have all five finger tips exposed for fishing tasks.

Boots—For summer wading, a pair of high top sneakers is ideal. Low sneakers with a boat or deck sole are best to prevent slipping when boat fishing. Cleats are essential on hip boots for working jetties, just as aluminum or steel, ribbed or spike cleats are necessary over hip boots or waders for much stream trout fishing.

Waders and hip boots are designed to keep anglers warm and dry. Hip boots come up to the hips and are held in place with belt straps. Waders are best when they come all the way to the arm pit to provide the maximum protection during surf fishing, wading trout streams, or deeper water.

Both hip boots and waders come in boot foot (molded-on boots) or stocking foot waders. Boot foot waders are self contained, heavier and the least nuisance. Stocking foot waders must be used with heavy socks and special wading shoes over the waders. They are lighter weight and ideal for traveling, but more difficult to put on and take off.

Rain gear—Rain gear is a must for any angler. Several styles are available. These include: the poncho style, best for boat fishing; 3/4 length style, good when worn with hip boots for lower leg protection or when fishing on the shore or from a boat; and the best, in the opinion of many, the two-piece pants and jacket style which is good for all types of fishing.

Rain gear is good not only for rain and snow, but also as a final layer over warm clothing to protect against heat loss in wind. The best rain gear is of a dark color so as not to scare the fish. Good rain gear will have a full hood for head protection, storm flaps over the jacket opening, a zipper instead of snaps or buttons, elastic in the cuffs and ankles to prevent water intrusion, and will be made of lightweight nylon fabric coated with a rubber or plastic waterproofing.

Protective Gear

Sun glasses and polarized glasses—Sun glasses are necessary outdoors, both as protection against the glare of the water and as protection from the UV (ultraviolet rays) that can damage the eyes. The best sun glasses for anglers are polarized and dark green or brown in color. A full lens wrap around (or side shield) style that will protect against glare reaching the eyes from the side is also desirable. Polarized plastic lenses are considered good. Sunglasses with specially treated lenses can stop the damaging UV. Polarizing lenses allow anglers to see below the glarrey surface of the water, to spot fish and bottom structure, and to cut the tiring surface glare.

Insect repellents—A number of insects can bother anglers and affect angling trips. Common ones include mosquitoes, chiggers, ticks, black flies, bees, wasps, and hornets. While they can't be avoided completely, precautions can limit their adverse effect on a trip. First, avoid areas with heavy infestations of insects. Second, do not wear cologne, perfume or other scents that might attract insects. Third, do not wear blue since mosquitoes seem to be attracted to this color. Use long sleeve shirts and pants for full body protection, turn collars up, and wear a head net, if necessary.

The best repellent is made of a substance known as DEET and most repellents use this, some being 100 percent DEET. Since DEET will damage any plastic items including picnic table cloths, fly lines, tackle boxes, lures, reel parts, and raincoats, the repellent must be used carefully. To avoid contact with these items, spread the lotion using the *back* of the hand.

Sun blockers—Sun tan lotions promote tanning. Anglers should try to avoid excessive tanning to prevent later possibilities of skin cancer, now proven to be caused by exposure to the sun. Use long sleeve shirts and long pants and wear a cap or hat to protect the head and neck. Always use a sun block designed to prevent UV rays from attacking the skin. The best are those containing PABA.

Most sun lotions today are rated by a number system. The higher the number, the greater the protection. The best for anglers are those numbered 15 or higher, which means that 15 hours in the sun with this sun screen will be no more damaging than one hour without any protection.

Sea sickness prevention—Common sense can prevent many problems with motion sickness. Eat lightly before going out in a boat, but do not eat highly spiced, greasy or unusual foods and do not drink alcoholic beverages. Pills are available to prevent or minimize motion sickness, with the better medications containing scopolamine as the active ingredient. Some sea sickness pills may cause drowsiness, in which case machinery, cars, boats or heavy equipment should not be operated. Take the pills according to the manufacturers instructions, in most cases, 1/2 to one hour before boarding a boat. Once on the boat, stay out in the fresh air and avoid cabins or areas where you will be near engine odors or exhaust smells. Also available through a doctor's prescription is a scopolamine patch that is applied behind one ear. Many individuals find these more effective than pills.

Ice fishing gear and precautions—Ice fishing requires some unique equipment and special care. Fish only on thick, new ice, preferably ice that is *at least* four inches thick. Use ice creepers or cleated boots to prevent slips. Ice fishing sleds are good for carrying tackle boxes, bait boxes, rods, vacuum jugs, lunch, wind shelters and screens. Ice fishing requires warm clothing, since the angler is exposed to the wind and cold without moving much. Snowmobile suits are ideal coupled with thick-sole insulated boots. Warm, protective hats, with skiers' masks for severe cold and gloves are a must. Hand warmers are also helpful.

Weather Considerations

Lightning—Lightning can be very dangerous. As as a storm approaches, get off the water. Once off the water, stay away from high, isolated structures, such as single or small groups of trees, towers, and metal buildings. If trapped on the water during a lightning storm, lay down all fishing rods, take down any radio antennas, and sit or lie flat to avoid being an elevated target. Be especially careful when using graphite fishing rods since graphite rods will attract lightning. Some manufacturers now post a warning on their graphite rods to this effect.

Wind and storms—Storms and high winds are dangerous for all fishing. If at all possible avoid fishing on stormy days or in high wind conditions. Wind will quickly create dangerous waves. Some boats, such as canoes and flat prow john boats, are ill suited for any storm, wind or wave conditions. Get off the water, or if this is impossible, face the boat into the waves and try to ride out the storm. If anchored, extend the anchor line to its full length.

Flash floods, reservoir releases, and low dams can also cause problems on rivers. Storms and rains, in particular, can cause rising waters, flooding, and swift, dangerous currents. Serious conditions can exist during calm days when fishing on rivers below hydroelectric dams, since a release of water for electric power will cause dangerous waters. This is equally dangerous to boaters, as well as to wading fishermen who can become caught in rising water, on small islands or spits of land, or those who are unable to fight the current even in shallow water to get back to the safety of the shore.

Low dams across rivers are also dangerous for boat anglers fishing below them. As a result of the hydraulics involved, these dams often cause upstream currents to pull small, drifting boats to the dam and under the falling water, sinking the boat. Often these same dams have large snags underneath them which can hold and drown anglers or form hydraulics which prevent swimmers—even those wearing a PFD—from reaching the surface. Particular caution must be used when wading and boating under these conditions.

Safety Around Water

Wading—wading requires particular caution by fishermen, whether in still or running water. Several basic rules apply for safe wading. It is important always to know the water and water conditions under which wading will be done. Knowledge of the bottom, water depth, slippery rocks, holes, current, and similar conditions are mandatory. Wading with a partner and wearing a PFD or some sort of flotation vest or device increases angler safety. While not legally required in most areas, such PFD's today have pockets for carrying tackle and are comfortable to wear. In addition, CO_2 inflatable flotation devices and vests, while not Coast Guard approved for boat use, are available for wading fishermen.

High top wading boots or shoes should be worn for ankle protection. Long, light weight pants are suggested for protection against salt water jellyfish and sea nettles, fresh water snags and rocks, as well as for sun protection.

Hip boots or waders are best for wading in spring or fall to protect against the chill of the water. Insulated boots are available for extremely cold weather wading. Boot foot waders are usually available in cleated soles for general use or felt soles for rocky stream use. Felt soles will wear out, but can be resoled and give maximum grip on slippery stream rocks.

PFD's—personal flotation devices—are required when boating by Coast Guard regulation and/or state law. The regulations generally require one wearable PFD for each boat passenger, along with a throwable cushion or ring for boats of a certain size and designation. PFD's are rated by type. Type I has the maximum flotation, is designed for rough waters, and will turn an unconscious person's head and face up to prevent drowning. It is reversible for quick wearing and is available in adult and child sizes.

Type II PFD's will also turn the wearer to a vertical and slightly backward position to prevent the unconscious from drowning. They come in three sizes but do not give the long term protection and flotation that the Type I does.

Type III PFD's are the type generally sold for recreational use and favored by fishermen. They frequently have pockets to double as fishing vests. They will maintain a face-up position but will not turn an unconscious person to this position. Many sizes are available in vest and jacket styles.

Type IV PFD's are designed to be grasped—not worn. They include flotation cushions and rings and are designed to be thrown to a person who has fallen overboard.

PFD's,with the exception of type IV, also help to maintain body heat in the water, and thus help in preventing or minimizing hypothermia.

Swimming—All anglers should know how to swim. Many like swimming as an adjunct to family fishing trips and picnics. Since swimming in these circumstances is not under the controlled situation of a regulated beach or pool, special cautions are necessary. Do not swim if there is any doubt as to ability or endurance. Practice all basic swimming safety procedures: do not dive in the water; do not drink and swim; do not swim after a heavy meal. Swim only when an experienced swimming partner is around, in the water or nearby. Do not swim in cold water since hypothermia can result.

Throw-row-go—This refers to a method of life saving by which any overboard person, swimmer or angler in trouble should be rescued. The first safety procedure is to throw a life saving device to them. This should be a type IV PFD such as a ring or cushion, preferably on the end of a rope. Lacking this, any floating object such as a cooler, ski belt, or beach ball will help. If this is not possible, row a boat to the person, preferably with an assistant in the boat to help pull the person over the stern and into the boat. If using a motor powered boat, the power must be cut before reaching the person to avoid prop injuries. Do not allow the person to try to pull himself into a small boat over the side since it might overturn. Only an experienced life guard or a person with life saving training should attempt to go in the water after the person. Drowning people will often panic and can hamper, injure or even drown their rescuers.

Hypothermia—Hypothermia is the chilling of a person beyond that person's ability to rewarm the body. The first sign of hypothermia is shivering. If not corrected, chilling of the body core causes weakness, hallucinations, uncontrollable limbs, and finally, unconsciousness and death. Part of the body's protection is to sacrifice the blood flow and maintenance of body heat in the limbs to protect and maintain body heat for the internal organs and brain.

One fallacy is that hypothermia can only occur in cold weather. In fact, it can occur in almost any temperature once the body begins to get cold or chilled through rain, wetting or wind. To prevent hypothermia, dress warmly, carry spare clothing, keep the head warm, and use a waterproof parka or rain gear to protect against loss of body heat due to rain and wind.

To treat someone with hypothermia, completely remove the wet or cold clothing and replace with warm clothing or place the person in a warm bath. The administration of hot, sweet drinks is approved, but no alcoholic beverage should be used. Do not warm the limbs and do not "exercise" the patient by walking. Warming the limbs will often cause increased blood flow to the limbs, resulting in a stroke, heart attack and death. In extreme cases, a warm bath with the arms and legs out of the bath water is ideal. A good substitute is a warm sleeping bag or electric blanket only covering the trunk, abdomen and head. Once it has been determined that a person has hypothermia in any of its stages, immediately call for an ambulance or other medical help. Hypothermia is not a casual concern and each year many fishermen and other outdoorsmen die from its effects.

Basic First Aid

Hook removal—Once a hook penetrates the skin past the barb, it is not easily removed. Unless penetration is very shallow or the victim is hours or more away from help, removal is best left to professionals in emergency rooms. In no cases should hooks be removed from around the eyes, from the face, from the back of the hands or from any area where ligaments, tendons or blood vessels are visible.

The simplest removal is to cut free the rest of the fishing lure and use a loop of heavy twine (heavy fishing monofilament is satisfactory) around the bend of the hook. Next, hold down the eye and shank of the hook, pressing it lightly into the skin. The downward pressure on the eye and shank of the hook clears the barb and allows it to travel out through the puncture wound. Grasp the mono or twine loop and with a sharp jerk, pull the hook free.

Other hook removal methods, including cutting the skin along the path of the hook penetration and forcing the hook out, are best left to professionals. Any hook wound should be followed with a tetanus shot if such protection is not already in effect.

Cuts and bleeding—Small cuts can be handled by adhesive bandages and antiseptic. Larger or deep cuts require pressure directly on the wound to prevent excessive bleeding. To do this, use sterile, sealed gauze pads or as an alternative, an unfolded clean handkerchief. In the case of severe bleeding in which an artery or vein has been cut, a tourniquet may be necessary as a last resort.

For cuts on arms and legs, the best direct pressure or tourniquet position is at the joint immediately above the cut where the major blood vessels travel over or near the bone. Use direct pressure here or a properly applied tourniquet to stop the flow of the blood. At all times be sure of proper procedure through training or a Red Cross course to prevent too much pressure or pressure for too long. In all cases of serious bleeding, call a doctor, get the patient to a hospital or call paramedics immediately.

Sunburn and insect bites are best avoided, but sometimes this is impossible. Cooling salves and lotions are the best relief for sunburn. Insect bites can be dangerous and it is estimated that insect stings, primarily from bees, kill more people than snake bites. If susceptible to extreme reactions from bee stings, carry specially prescribed injection kits for such emergencies.

For most, removal of the stinger and the immediate application of an analgesic/anesthetic balm or a paste of baking soda will help to relieve the pain, reduce swelling and minimize any itching or inflammation.

Other medical problems include heart attacks, snake bites and other rare, but severe, medical emergencies. CPR is good training for anyone, especially anglers who might need to utilize this skill. CPR requires special extensive training, and courses and books beyond the scope of this manual are available through the Red Cross.

Snake bites are rare if snakes are not annoyed or trapped. Most snake bites are from non-poisonous snakes but still should be treated by a doctor due to the possibility of infection. Bites from poisonous snakes once were treated by cutting and suction, but this is no longer suggested unless done by an experienced technician. The best advice today is to keep the patient calm, reduce any exertion or movement, chill the struck area with ice (but not long enough to cause frostbite!) and get the patient to a doctor or hospital immediately.

LESSON 7

Shore Fishing

LESSON

7

Shore Fishing

Lesson Objectives

Following this lesson students will:

1. Know that fishing from shore can provide an enjoyable fishing experience.
2. Realize that shore fishing requires little in the way of special equipment or techniques.
3. Understand the advantages and disadvantages of fishing from the shore.
4. Be familiar with how to fish banks, piers, jetties, bridges, and walkways.
5. Know some safety precautions necessary for shore fishing.
6. Understand the necessity of a careful approach to water when fishing from shore.
7. Realize the importance of gaining permission when fishing private land, the need for controlling litter, and the necessity of a license.
8. Know the basics of ice fishing including tackle and safety precautions.

Materials for the Lesson

1. Examples of the types of tackle utilized by shore anglers in your area. Surf and jetty rods, ice fishing tackle, and stream and lake tackle.
2. Safety equipment used in local shore fishing: PFD's, jetty cleats, wading shoes, waders, hip boots and insulated boots and shoes. A local sporting goods dealer can be asked to display many of the items in #1 and #2.
3. Photocopies and overhead transparencies for classroom use, of the graphics in the appendix.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	1. Introduce students to the lesson objectives.
II. Locations A. Pond and Lake Banks B. Stream andRiver Banks C. Surf Fishing D. Piers E. Jetties F. Walkways G. Bridges **III. Advantages and Disadvantages** A. Advantages 1. Cost 2. Easy Access 3. Fish Availability 4. Family, Group Activity B. Disadvantages 1. Restricted Fishing Area 2. Crowding	2. Ask students to relate personal experiences they have had fishing from shore. List these on a chalkboard. As you are discussing this, have students describe the equipment they used. As specific equipment is mentioned, show that equipment to the class. Some students may not be familiar with certain types. 3. Ask the students why they fish from shore. Responses will vary, but weave into the discussion shore fishing advantages. 4. Discuss the disadvantages of fishing from shore. The concepts of crowding and being able to fish only certain parts of the lakes, etc., may be responses.
IV. Safety A. Water Safety B. Fishing Safety	5. Safety in all fishing is important, and no less so with shoreline fishing. Stress the safety aspect by showing several of the safety apparel items available. Describe their use; ask students if they or their friends or parents have utilized them; why they are important. Continue with other safety aspects concerning the use of equipment and special safety concerns in specific types of shore fishing situations, e.g., piers, jetties and wading.
V. Tackle	6. In most cases, fishing tackle for shore fishing is no different than that used in other types of fishing. Discuss basic equipment, especially cane poles and spincast. Ask students to tell what type of equipment they use, and why. Discuss the different shore fishing tackle for specific purposes. Surf, ice, pier, jetty, and walkway fishing require specialized equipment. Discuss the most commonly used tackle locally.

Lesson Content Outline	Classroom Procedure
VI. Approach to Shore Fishing A. Walking Banks B. Vibration C. Sight Window of Fish	7. Fish are wary creatures. This has implications for bank anglers. They must be careful not to make loud noise while on bank, to keep a low profile, and not throw items into the water. Ask students how they can remain disguised while bank fishing. Explain how fish can see through a "window" in the water. The graphic on fish vision may be of assistance here.
VII. Ethics, Permission, Responsibility	8. Much shoreline fishing is done on private property. Ask the students how many of them fish on someone's property. This is a good starting place to introduce ethics, respect for property and the rights of others, and the individual responsibility that each of us has to preserve and enhance the resource. Ask those students who have fished on someone else's property to relate their experience. Work the concepts of asking permission, picking up litter, closing gates, not damaging property, and other such ideas into the disucssion. Ask all students to suggest ideas they have concerning everyone's responsibility to the resource. Write specific suggestions on the chalkboard.
VIII. Ice Fishing	9. Ice fishing is a special kind of fishing. If appropriate for your area of the country, briefly discuss all aspects of ice fishing including equipment, clothing, safety, types of fish caught, and thickness of ice required.

INTRODUCTION

Fishing from the shore offers unique advantages to the angler. It allows access to a number of waterways ranging from surf fishing the Atlantic, Pacific or Gulf Coasts, to lake and pond fishing, stream and river fishing, and fishing from manmade structures such as piers, jetties, walkways and bridges.

Shore fishing is available to everyone, allowing for large family and club groups to fish together and low in cost since it does not require boat ownership or rental.

Safety and tackle concerns, while important, are minimal when shore fishing, but anglers must know how to approach an area to maximize fishing effort. Anglers must be aware that fish can see through the water to view anglers on a bank and that vibrations from walking anglers will signal danger to fish.

Since much shore fishing is done on private property, good landowner relations are a must to prevent loss of access for all anglers. Gaining permission to fish and showing respect for all private property are the keys to being welcomed by landowners.

Some specialized shore fishing exists such as surf fishing and ice fishing, which is not from the shore, but from a stationary position on the ice.

NARRATIVE

Locations

Millions of anglers fish exclusively from the bank or shore and millions more often fish this way. Fishing from the shore will often control the type of fish caught. Free swimming ocean species are not found close to the shore for surf fishermen. Free swimming lake species such as trout and salmon are not often found close to the shore for inland bank and shore anglers. Shore caught species include those fish that are bottom feeders such as carp, catfish, suckers and walleye or those that relate to structure such as smallmouth and largemouth bass, pike, stream trout, and sunfish.

The big advantage of shore fishing is that almost everyone has some water near home that will produce good angling. Lakes and ponds provide good fishing. Many of them have shoreline structure such as logs, stump fields, brush and rock piles, duck blinds, docks, and downed trees which provide shelter, shade, and protection for fish and make for ideal fishing spots.

Lakes and ponds also allow for easy movement to many spots along the shore by simply walking or driving to a new location. Often the best spots are those that are out of the way from easy access and roads, since most anglers will fish these closer locations and can temporarily reduce the numbers of fish available. Less accessible areas can often provide better, almost private, fishing.

Streams and rivers are also good locations for fishing, particularly those that have good structure in log jams, rocks, islands, sand bars, and rock piles within casting distance of the shore. Many anglers fishing shallow rivers will combine shore fishing with shallow water wading. Fishing from midstream in rivers or streams increases opportunities for casting to different structure.

Surf fishing is a specialized type of shore fishing. Anglers fish from the shore or wade into the water along the coasts—Atlantic, Pacific and Gulf. There is usually little visible structure to which to cast, so anglers must become familiar with "reading" the water to detect shallow sloughs, pockets, tide rips and such areas where fish may be present.

The tackle for surf fishing is different from that used for other inland shore fishing since the fish are bigger and the sinkers to hold a lure or bait on the bottom are heavy. Thus, heavy reels, usually spinning, are used, spooled with 12 to 20 pound test line and fitted on long, heavy rods that range from 8 to 12 or more feet in length. Casts are long and bait is most often used unless fish are visible in the area; then lures are often used.

Fishing piers are elevated structures above the water that extend into the waterway. They can be from a few dozen to several hundred feet long and anywhere from only a few feet to 20 or 30 feet above the water surface. Piers allow more anglers to fish a given area and also to get their lures and bait further out into the water than a cast from shore would allow.

Pier tackle is usually slightly heavier than that used for most shore fishing since long casts are a must and the hooked fish must be controlled until a bridge or pier gaff or net can be dropped to land them. Often the pier is built with rock piles or structure adjacent to it to help hold fish for fishermen. Lacking this, even the pilings of the pier serve as structure to help foster a food chain and to help provide shade and shelter for game fish. In these cases, often the best fishing can be right under the pier.

Jetties are similar to piers in that they are built out into the water and provide a platform from which to fish. Most jetties are built to protect harbor areas and boat slips from wave action, thus are built along the shores of larger lakes and oceans. Most jetties designed for fishing have the rocks arranged so that they are flat on top for easy walking. Some jetties do not have this feature and require that extreme caution be taken. Jetties are frequently washed with water from wave action so that cleats are required for safe fishing. Jetties, because of their rock base, provide a good locale for a food chain and shelter for game fish.

Walkways are similar to piers but usually consist of specially built fishing platforms that are associated with or run parallel to bridges, piers, shoreline bulkheads, or similar shoreline structures. They are made especially for fishing and are separated from the adjacent structure. An example would be a separate walkway at a lower level along a bridge in order to keep anglers from hooking cars when making casts, to place anglers closer to the water for easier fishing, and to prevent any pedestrian accidents caused by anglers fishing from the bridge.

Bridges are not always open to fishing. Fishing is prohibited from many of them due to high traffic volume, no shoulder area for fishing access, spans that are too high, and lack of good parking access. Bridges that do offer fishing must be fished safely to prevent snagging cars and must have adequate space for anglers consistent with safety and traffic movement and volume.

Advantages of Shore Fishing

Lower cost is the big advantage to fishing from the shore. All that is needed is basic tackle, a fishing license and a shoreline. Admittedly, in some areas, entrance fees are charged for fishing from private fishing piers, but these are minimal.

Easy access is another shore fishing advantage. A nearby pond, lake, stream or river can be found virtually everywhere. Boat fishing, on the other hand, often requires waters of a certain size and type to be effective. Some anglers buy several different boats for fishing on different types of water, again increasing the cost of boat fishing. Thus, for a club, several friends, a large family or a similar group, the shore fishing experience can be combined with a picnic, family gathering, or shore lunch so that all involved enjoy the comradarie of a large group. This does not preclude shoreline fishing from being an individual sport. It does mean that shoreline fishing can involve large or small numbers of fishermen.

Safety

Safety in all fishing is important, no less so with shoreline fishing. While the dangers and concerns of boat fishing are not involved, safety must still be paramount. This begins with the site selection. Private property must be fished only with permission, not only as a courtesy, but also to be aware of any dangers such as cattle in pastures, planned pesticide crop spraying, or mud holes that might stall cars.

Safety also involves the handling of rods, reels, line and hooks to prevent fishing accidents. Those anglers combining shore fishing with wading in the surf, streams, ponds, or rivers must use caution, preferably wear a PFD, have proper foot wear, and be prepared for temperatures which can cause hypothermia.

Safety when casting is a must when fishing in and around large groups of people, off of a bridge, off of a pier or jetty, or anywhere people or obstructions might get hooked. Piers and jetties also have some specific concerns. Jetties, because they are very slippery, must almost always be fished in cleated shoes. Cleat styles vary with different locations but include soft aluminum cleats or strap on cleats that will cut through any slime or sea weed and grip the rocks.

Surf fishermen also need special equipment, such as waders or hip boots, to stay dry along the surf or when wading in the shallows.

Tackle

Tackle for shore fishing is, in most cases, no different from that used for boat fishing under the same conditions and for the same species. Freshwater tackle is usually light for sunfish, small catfish, trout, stream smallmouth, suckers, and small walleye. It is medium for largemouth, lake smallmouth, pike, carp, large catfish and salmon. Heavy tackle is necessary for large salmon, muskie, stripers, and large carp. When salt water fishing, medium to heavy tackle is a must, if not for the fish, for the heavy sinkers that must be cast to hold the bait and lures on the bottom against the prevalent currents and changing salt water tides.

Surf fishing also requires special accessory tackle, such as sand spikes, to hold rods elevated. Other tackle for wading surf fishermen includes surf belts, which hold small landing gaffs, stringers, lure bags and holders, flashlights for night fishing, and spare line spools. Pier fishermen often use small carts to hold extra rods, tackle boxes, bait containers and rod holders for transporting their tackle. Jetty fishermen also need special cleated shoes.

Approach

Fish are always wary and especially so in shallow water near the shoreline. Thus, shore fishermen must walk carefully since bank vibration from walking can be transmitted to the water and scare the fish. Vibration is less a problem when fishing streams since the current covers any bank and shore vibration. Wading fishermen should avoid dislodging rocks that might make sounds that scare fish. It is no problem when fishing from jetties and piers since no appreciable vibration will be transmitted to the water to scare fish.

When fishing still water, anglers fishing close to the shore must also avoid being seen by the fish. Fish near to the surface can see through the water surface by a "window" that refracts the picture so that a cone of vision is possible. As a result, anglers fishing close to the shore should stay low to avoid being seen, stay near shrubbery to remain disguised, or wear dull or camouflaged clothing to hide from the fish.

Ethics and Permission

Much shoreline fishing is on public property owned by the state or federal government, but much is done on land owned by individuals or other groups. When fishing on public lands, permits are sometimes needed to control access or reduce crowding. When fishing private property, permission is necessary from the land owner. The best permission is a signed slip giving permission to fish on the property, either on a recurring basis or for a specific time period. However, verbal permission is usually satisfactory. When gaining permission, be sure to pay attention to any specific requests or regulations of the landowner. Common requests include making sure that all gates are left as they were (open or closed, as the case may be), avoiding crops to prevent damage, and cattle to prevent accidents, and staying away from any restricted water areas.

Ethics also requires that all fishing areas are left cleaner than when found. Remove all litter and take only those fish permitted by the land owner. Even if state regulations are more liberal than the landowner host limits, respect and common sense indicate that the lesser limits be honored to assure of being invited back. Also, it is often helpful to present a fish or two to the host. If accepted, make sure to offer to clean or fillet the fish for the host at the same time.

Ice Fishing

Ice fishing, while not specifically shore fishing, is fishing from a stationary position, thus involving many of the same concerns as shore fishing. Ice fishing is practiced in a number of Northern states each winter and provides excellent fishing for bass, panfish, pike, walleye and similar lake and deep water species. The main concern for all fishermen is the thickness and condition of the ice. Most experts agree that ice thickness should be at least two inches for individual fishermen, three inches for small groups and four inches for larger groups of anglers. Many feel that four inches is a minimum thickness for any fishing to provide a good safety margin.

Ice fishing requires comfortable layered clothing to protect against the wind and cold found on lakes. In addition, heavy insulated shoes or boots must be worn to prevent chilled feet. As an alternative, layers of cardboard, plastic foam or carpeting will work as insulation between the ice and feet.

Fishing is done through holes drilled in the ice. Holes should not be chopped in the ice since an ice chunk can glance off and cause injury. Special hand and motorized ice augers are available to drill smooth holes.

Tackle for ice fishing varies from other tackle. Fishing can be done with tip ups, special pre-set fishing lines that fit over a hole and do not require individual attention. When a fish hits, it releases a trip lever, causing a flag to alert the angler. Most states limit the number of tip ups and holes which can be used.

Rods can also be used, with most serious ice fishermen using very short rods of only one to three feet in length and simple reels or winders to hold the line. Common lures include small spoons and jigs, often tipped with grubs and small baits.

UNIT II

BECOMING A BETTER ANGLER

LESSON 8

Tackle Types—Spincast and Spinning

LESSON
8

Tackle Types—Spincast and Spinning

Lesson Objectives

Following this lesson students will:

1. Know basic types of tackle and its uses.
2. Be able to identify the parts of spinning and spincast tackle.
3. Understand how tackle is "balanced," and why this is important.
4. Know the uses of terminal tackle.
5. Understand the similarities and differences of spincast and spinning tackle.
6. Be able to use spinning and spincast tackle.
7. Be familiar with basic spincast and spinning lures.

Materials for the Lesson

1. Several spinning and spincast rods and reels, of different sizes and brands.
2. Practice plugs for each rod and reel outfit.
3. Small lures, rigs, hooks, and terminal tackle suited for this tackle in your locality.
4. Tin cans, hula hoops, or other items to use as targets for casting practice.
5. Copies of graphics to use as overheads or as photocopies for individual students.
6. Any booklets or other printed materials or wall charts received from manufacturers to distribute to students.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Tackle Basics, General	1. Introduce class to the lesson objectives.
A. Basic Tackle B. Tackle for Different Waters, Lures, and Baits	2. Begin with a discussion of the variety of fishing equipment available. Explain that the tackle utilized depends upon the conditions to be fished and the fish sought, but this lesson will focus on the use of spinning and spincast equipment.
C. Balancing Tackle	3. Explain the concept of balancing tackle. It does not mean how a rod and reel balances on your finger, but that the rod, reel, line, and lure are in proper relation to each other. Show, and pass around to the students, a properly balanced fishing outfit—a light spincast or spinning outfit with 4 to 8 lb. line and a 1/8 to 1/4 oz. casting plug. If space permits, demonstrate its casting ability. (This can wait till later.) Then show an improperly balanced outfit. (Similar to the first one, but utilizing a very heavy plug.) Show how the heavy weight is too much for the small rod and reel and light line. Ask the students what problems this could cause. (Loss of lure due to line breakage, broken rod, etc.) Also discuss the use of heavy line with light rods and small reels and potential problems with spooling the line.
D. Terminal Tackle 1. Hooks	4. Using the graphics available, discuss different hook sizes and the importance of selecting the proper size for the fish and for the equipment. Talk about the parts of a hook and how double and treble hooks are used on many lures. Distribute hooks of various sizes and styles that are locally popular, including jigs and snelled hooks.
2. Sinkers 3. Floats a. Bobber Stops b. Submerged Floats	5. Show several different sizes and styles of sinkers and floats (bobbers). Discuss the purpose of these terminal tackle items. Distribute to students, along with some pieces of fishing line, and have them attach the different types of sinkers and floats, including those with bobber stops.
4. Prepared Rigs 5. Leaders	6. Distribute two or three prepared bait rigs to show different methods of rigging terminal tackle. Also discuss the use of leaders and why they are utilized in some situations. This should receive emphasis with older or more advanced students.
6. Snaps, Swivels	7. For older or advanced students distribute and discuss the use of snaps and swivels, the different types and the advantages and disadvantages of each.

Lesson Content Outline	Classroom Procedure
II. Spincast Tackle A. Reels B. Rods C. Line D. Uses E. Casting Technique F. Basic Spincast Lures	8. Distribute photocopied materials for spincast tackle. Use a prepared overhead projector transparency if possible, or if not, a rod and reel to discuss and point out the parts of this equipment. Distribute small lures (jigs, spinners, plugs, spoons, etc.) popular in your area. Discuss their use and what types of fish they can be utilized for locally. Use graphics of casting technique and discuss and demonstrate the proper techniques of casting including the proper grip, stance, and casting fundamentals. Explain that everyone will get an opportunity to practice these techniques. Stress the importance of accuracy over distance.
III. Spinning Tackle A. Reels B. Rods C. Line D. Uses E. Casting Technique F. Basic Spincast Lures	9. Distribute photocopied materials for spinning tackle. Proceed as in #8 above. 10. Move the class to an area where casting can be performed by the class. Distribute equipment, both spincast and spinning. If you do not have an assistant or two, limit the number casting at any one time to a maximum of 3–5 so that you can give them individual assistance. Have the other students listen and learn from the others' experience. Stress technique and accuracy as the students cast toward the targets that have been provided. Stress the importance of safety. Even though there are no hooks now, there will be later. It is important for them to know where the "lure" is on the backcast and to cast the lure toward a specific target. With beginning students, work only with the backcast. Side casts, underhand casts, and other more advanced techniques could be appropriately taught to older or more advanced or experienced anglers.

INTRODUCTION

Fishing tackle can be very simple and consist of nothing more than a hand line, hook, bobber and sinker. It can also be more complex, such as the tackle used for saltwater trolling, bait casting or fly casting. Some tackle, while complex in design, is very simple to use. This is the case with spincast and spinning tackle. Both work on the same principle, even though they look completely different.

Other than the simplest tackle made up of a hand-line or cane pole, all tackle consists of several elements. These include a reel, rod, line and the terminal tackle including a hook, sinker and bobber or a lure. Each serves a purpose. The reel holds the line which is the sole connection between the angler and the fish. The reel can hold more than enough line so a fish may "run" after taking the bait. The line must be thin, strong, and have good knot strength. The rod serves as a "leaf spring" or shock absorber to propel a lure or bait into the water and also to act as a lever with which to fight and land fish.

Tackle is designed for a particular purpose. Spinning and spincast tackle is ideal for beginners and for much light tackle fishing.

NARRATIVE

Tackle Types

Basic Tackle-Hand Lines

One of the basic ways of fishing is with a hand line. A hand line is simply a fishing line wrapped around some type of holder. It may have a sinker and float with a baited hook on the end. To use or "cast" a hand line, coils of line are held in the hand or placed on the ground and the terminal tackle end (hook, sinker and float) is spun around the head and released to fly out into the water.

Cane Poles

Cane poles are generally not utilized to cast or to throw the line. They consist of a long cane pole, although other pole materials can be used, with a line tied to the end. While carrying or storing, the line is spiraled down the pole for security.

The baited hook, sinker and float are lobbed or swung out into the water. To make fish landing easy, the line is usually not longer than the length of the pole.

Casting Tackle

Casting tackle utilizes a revolving spool reel that requires the angler to control the spool rotation to prevent tangles or "backlashes." A button or lever places the reel into "free spool" for casting. The rod is similar to that used for spincasting, only with a stiffer action. Monofilament line is used most often, although some anglers use braided dacron.

Fly Tackle

Fly tackle is completely different from other types of tackle with which a lure or weight is cast. In fly casting the line is cast rather than a lure. The fly "goes along for the ride" and is attached to the thick fly line with a tapered monofilament leader. Fly reels are usually single action with no gearing and serve primarily as storage for the line. Fly rods are long (7 to 10 feet), limber, and equipped with small guides. The reel is mounted below the grip.

Surf Tackle

Surf tackle is heavy. Long, stiff rods, ranging in length from 9 to 14 feet, allow the angler to make long casts with heavy lures. The long rods also hold the line up above the breakers, which would otherwise catch the line and drag the bait. Surf tackle can be either spinning or revolving spool style, although most anglers fish the easier-to-use spinning style.

Trolling Tackle

Trolling tackle is also heavy tackle, either spinning or casting, in which 6 1/2 to 8 foot rods are used with large reels that have great line capacity. Trolling tackle is used to trail a lure or bait behind the boat. Usually the rods are held in rod holders, and have long handles. Line test is usually heavy.

In salt water, many anglers use lines that correspond to tournament and record "line classes" from 8 to 130 pound test line. The rods are relatively short to allow for leverage in fighting hooked fish.

Tackle for Specific Fishing Conditions

The first consideration in any tackle choice is the fish sought. The size, food habits and depth of the fish are critical in choosing tackle. For large fish, heavy tackle is a must. For small fish, light tackle should be used. Fish that are strong and make long runs must be raised off the bottom with a stout rod.

Cover and habitat are important considerations in tackle selection. River smallmouth in open water can be fished for with lighter tackle than similar size largemouth found in brush and log jams in a lake or slough. Open-water barracuda can be caught on light tackle while reef-hiding grouper of the same size require heavy tackle to get them out of the reef.

Food preferences of fish also determine tackle choice. The prevalence of trout eating mayflies, caddis flies, stone flies, and small aquatic insects, makes the fly rod ideal for stream fishing. Bottom feeders do not require a rod and reel that will cast well, while fish that strike lures and require repeated accurate casting are a different story altogether. Stiff action rods are preferred for fish that strike surface lures since the stiff rod allows the angler to work these lures properly.

The kind and type of water also determine tackle. Ponds and small streams can be fished with light tackle since they usually contain smaller fish. Offshore fishing in salt water requires trolling a bait and utilizing larger, heavier tackle necessary for the much larger fish.

Balancing Tackle

Tackle balance is often misunderstood. Many anglers think that it means how a rod and reel balances on the finger or hand in terms of being tip or butt heavy. While this is important for fishing comfort, balancing means that the elements of the fishing tackle outfit—rod, reel, line, lure—are in proper relation to each other.

Often anglers choose the rod and reel first and then the other tackle items. Usually it is best to work in reverse. Understand the fish sought after and the fishing conditions. The type and size (weight) of the lure/bait will then determine the line. To fish effectively the line size and lure weight determine the required reel size and the rod strength and length.

It is extremely difficult to cast with heavy line. The wiriness of the line and its resistance when coming off the reel render it impossible to make a reasonable cast with a small lure. A heavy line attached to a small or light lure restricts lure movement. On the other hand, a heavy lure might break light line during a cast as well as the smaller lines being too light to hold once a fish strikes.

Similarly, a heavy line does not spool well on the tiny spools of an ultra-light spinning reel. The reel spool is too small to hold enough line, and the line is too wiry and heavy to cast well, even with an appropriate size lure. A large reel can hold very light line but requires great amounts to fill up the reel for good casting. A light rod can break when casting a heavy lure, and a heavy rod does not flex properly to cast a light lure.

Terminal Tackle

Terminal tackle refers to those items—hooks, floats, sinkers and snaps, swivels and connector links—that are attached to the end of the line to properly get the lure or bait to the fish.

1. Hooks—Hooks come in many styles and sizes, each suited for a particular purpose. Hook sizes, points, lengths, sturdiness (thickness of hook shank), shank shape, eye, and finish vary widely. Treble hooks are used on most plugs. Special hooks are designed for minnows, offshore riggings, frogs, and crickets. In the case of jigs and hooks for soft plastic worms, dozens of styles are available. For bait fishing, many hooks are "snelled."
2. Sinkers—As with hooks, sinkers also vary in weight, size, shape and style. A sinker is designed to sink the bait. Some sinkers, such as pyramid and bank styles are used to hold baited hooks on the bottom. Others such as pinch on, rubber core, wire twists and split shot, fasten to the line.
3. Floats—Surface floats are designed to hold a baited hook and sinker off the bottom. Floats are round or tapered, with the best floats just large enough to hold the other terminal tackle up. In this way they are more sensitive to fish bites. Bobber stops allow bobbers (floats) to slide along the line, so that deep fishing can be done and the rig can still be cast. (The bobber slides up to the sinker/hook on the retrieve and cast and slides down to the preset bobber stop after landing in the water.) Submerged floats are used with sinkers to hold a bait or lure up off the bottom, above weeds or free of snags. These usually slide on the line.
4. Prepared rigs—Prepared rigs are available for bait fishermen. While these will vary in style and materials, they usually are single or double hook bottom rigs, trolling rigs, or drift rigs that require only the addition of a sinker, the necessary snelled hooks, and the bait. Some rigs are sold with the snelled hooks and sinker included so that the rig only has to be tied to the line to be ready for fishing.
5. Leaders—Leaders can range from very short three inch long wire leaders, often used for fishing for toothy fish (pike, bluefish, barracuda), up to long leaders for trolling, fly fishing, casting, and surf fishing. Leaders come with a snap on one end and a loop or swivel on the other and are tied between the line and the lure or bait. Most leaders are available in monofilament, wire and nylon coated wire in different strengths for different fishing.
6. Snaps, swivels—Snaps or swivels can vary from very small to very large and from inexpensive models on up to expensive, but better performing, ball bearing styles. Snaps are available with and without swivels attached. Swivels and snap swivels are particularly important for trolling and when fishing any bait or lure that can cause line twist.

Spincast Tackle

Reel—Spincast reels, sometimes called American spinning reels, are the easiest type of reel to use. The line is released through a small hole in the nose cone of the reel. It comes out straight, unlike spinning, yet allows the casting and fishing of lightweight lures and bait.

All spincast reels are similar in that the line is held on a shallow spool within the nose cone. A pick up pin rotates around the front of the spool to pick up the line as it is retrieved. The reel fits on top of the rod handle and is cast using an action similar to that used with a baitcasting outfit. The handle can be single or double. It is almost always found on the right side of the reel, but some newer reels have right/left interchangeable handles. The drag system can be a simple drag, set by a small lever or knob on the top or side of the reel, or a star drag system as seen on bait cast and salt water reels. The antireverse lever or knob (slide lock) prevents turning the handle backward and forces the drag to control or slow outgoing line as a fish runs. The foot or polemount allows mounting of the reel onto a spin cast rod.

Rod—Spincast rods are designed for fresh or very light salt water fishing and are very similar to casting rods. They include a similar low profile, off-set reel seat, and larger guides for the line, all on rods that vary between 4 1/2 feet and 6 feet in length. Most rods will be of medium power for casting 1/4 to 3/4 ounce lures. The easy release of line from the spincast reel makes casts with lighter lures possible.

Spincast Uses—Spincast tackle is best used for smaller fish in fresh water It is ideal for panfish, small catfish, bass, trout, sauger and white bass. It is rarely used in salt water, but could be used for small inland species also. It is ideal as a beginner's or occasional user's tackle since there is no possibility of tangled loops which can occur with spinning tackle, or spool overruns (backlashes), which can occur with casting tackle. It can be used with lures or bait, and most modern outfits have a good drag system and sufficient line capacity to handle any of the above fish or similar species.

Casting Technique—The spincast rod and reel must be assembled properly, with the reel mounted securely on the reel seat of the rod. If the line is not visible, twist off the nose cone of the reel (see the instruction guide), pull the line through the line outlet in the nose cone, and reassemble. Next, thread the line through the guides. After the line is run through the guides, tie on a weight. A 1/4 to 3/8 ounce practice plug is best.

Basic spincast lures—Spincast lures are not really any different from any other type of lure. The light weight spincast outfit will best cast lightweight lures such as small jigs, spinners, tiny spinnerbaits, small plugs, top water lures, plastic worms and grubs, small spoons and small pieces of bait. Be sure to select lures that will cast well and are suited to catch the fish sought after.

Spinning Tackle

Reel—Spinning reels work on the same principle as spincast reels but do have noticeable differences. First, the spool is exposed. Second, the reel hangs underneath the rod, thus has a slightly more comfortable feel and balance for a long day of fishing. Spinning reel spools, because they are not enclosed in a nose cone, have a much greater line capacity. Spinning reels, also called open face reels, come in a very wide range of sizes, from tiny ultralight reels weighing only a few ounces to massive surf casting and boat fishing salt water models. Spinning reels work on the principle that the cast lure pulls the coiled line from the reel rather than causing the spool to rotate as with casting reels. Spinning reels are ideal for most fishing.

The reel foot or polemount holds the reel onto the spinning rod reel seat. The body of the spinning reel holds the gearing necessary to turn the bail and cause the reel spool to move in and out to lay the line down evenly. The spool holds the line. Spool sizes vary with the reel size, and line capacities range from as little as 165 yards of four pound test line to as much as 200 or more yards of 20 pound test line. The handles on spinning reels are usually interchangable so that both right and left hand casters can use the same reel. The bail usually has a roller on which the line rolls as it is retrieved. This roller prevents line wear. The bail also flips open to allow casting. Bails automatically flip closed when the handle is turned. The drag of the reel is adjusted by knobs on either the front of the spool or rear of the body. The drag must be adjusted to less than the breaking strength of the line.

Rod—Spinning rods are usually longer and lighter than equivalent rods for conventional (rotating spool) reels. Spinning rods can vary, however from tiny four foot long ultra light models through 6 foot models, to 7 foot boat models, and 12 foot or longer surf rods. There are trigger or finger grips on the reel seat, and all have large guides to help the loops or coils of line "funnel" down as they go through the guides. The reel hangs underneath the rod and the angler usually places two fingers on each side of the reel shaft.

Uses—Spinning tackle can be used for everything from ultra light panfishing to trolling offshore for marlin and sailfish. Naturally, the right tackle must be chosen for the fish sought, and all parts of the tackle package—rod, reel, line and lure—must be properly matched.

Basic spinning lures—Basic spinning lures include just about any lure designed for casting. Bucktails, jigs, topwater lures, spinners, plugs, spinnerbaits, worms, spoons, buzzbaits and inline spinners are all easy to cast with any type of spinning tackle. It is important that the outfit match the weight and type of lure used and that the lure match the fish sought.

LESSON 9

Tackle Types—Casting and Fly

LESSON
9
Tackle Types—Casting and Fly

Lesson Objectives

Following this lesson students will:

1. Understand the uses of fly and revolving spool tackle.
2. Be able to cast with fly and revolving spool tackle.
3. Be able to identify the components of casting and fly fishing tackle.
4. Know how to correctly match fly and revolving spool tackle for specific fishing conditions.
5. Know when to utilize fly and revolving spool tackle.

Materials for the Lesson

1. Several casting (revolving spool) rods and reels of different sizes and brands.
2. Several fly casting rods and reels of different sizes.
3. Several types and sizes of fly lines.
4. Practice plugs for casting revolving spool tackle and leaders and hookless bugs for fly casting.
5. Several different types and sizes of locally popular artificial lures and and styles of flies and bugs for fly fishing.
6. Tin cans, hula hoops or other items to use as targets for casting practice.
7. Copies of graphics to use on overhead projectors or photocopies for individual students.
8. Any booklets, printed materials, or wall charts received from manufacturers.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	1. Introduce class to the lesson objectives.
A. Tackle Differences	2. Both casting tackle and fly fishing tackle are often used by advanced anglers. Since the line spool revolves in casting tackle, a big difference between this tackle and spinning or spincast tackle, it is much more difficult to use, even though new advances have made the equipment easier.Because of the revolving spool, anglers often experience "backlashes" which are a result of the spool continuing to revolve after line has stopped being taken from the spool. Fly tackle is more difficult to utilize since the line is cast rather than the lure. Both types of tackle are excellent for many fishing situations, but they both require more practice for effective use.
B. Balancing Tackle	3. Balancing casting and fly fishing tackle is just as important as for spincast or spinning equipment. Balancing tackle for casting equipment is very similar to balancing spinning or spincast equipment. However, fly fishing equipment requires that the weight or size of the rod by matched to the weight or size of the line. Since the lures are extremely light, they really are not as much of a factor in balancing fly fishing tackle.
II. Casting (Revolving) Spool Tackle A. Reels B. Rods	4. Distribute the photocopied graphics to students and utilize overhead transparencies to show a casting outfit. Discuss the specific parts of casting rods and reels. During this procedure, the class can benefit from being able to pass around and look at balanced outfits that will later be used to practice casting. Stress that casting reels are essentially winches to take in line. Discuss the parts of the reel at some length including the star drag, the cast control knob, magnetic drag system, and their uses to simplify casting and lessen the possibility of backlash or line breakage while fighting fish. For advanced students the "flippin" feature should also be discussed. Inform the students that many larger rods and reels used for trolling and large water fishing operate on the same principles as the smaller freshwater reels and rods.
C. Casting Techniques	5. Use graphics of proper casting procedure to discuss effective casting. The technique for casting equipment is very similar to that used for spincast and spinning with the exception of using the thumb to assist in controlling the revolution of the spool. Demonstrate how to correctly hold the rod and reel, how to make the backcast, and the importance of the rod bending so that the lure will be propelled from the rod. Stress the importance of accuracy.

Lesson Content Outline	Classroom Procedure
D. Uses	6. Casting tackle can be utilized for nearly all types of fishing and species of fish. It can be utilized for both fresh and salt water fishing; from piers and shore, as well as trolling or jigging.
E. Lures	7. The variety of lures for casting equipment are only limited to the imagination. They come in all sizes, colors, and styles. They should be matched to the equipment, line size, and type of species sought. Examples can be passed among the students and effective lures for the local area can be discussed.
F. Line	8. Monofilament line is almost universally used for bait casting tackle. A few anglers do use Dacron braided line because of it's low stretch. When using braided line, a leader of mono is usually used to separate the visible braided line from the lure.
III. Fly Fishing Tackle A. Rods B. Reels	9. Fly fishing is much different from other types because the line is cast rather than the lure. The casting procedure is more difficult for some people to learn. However, any angler willing to practice can become proficient. Distribute photocopied graphics from the appendix and utilize an overhead transpanency or fly rod and reel outfit to acquaint the class with the parts of fly fishing tackle. Note the difference in the reel, which is utilized primarily as a line holding device. This is a big difference between this and other types of fishing reels. Note also, the length of the rod which is much longer than those used in most other types of fishing. Discuss the rod sizes and the "coding" which indicates the power of the rod and the line size that should be matched to the rod.
C. Fly Line	10. Fly lines vary by their shape. They are made with a plastic coating over a braided core and are made to different tapers. Utilize an overhead transparency and distribute photocopied graphics to students so that they can see the differences. Discuss weight forward, double taper, level, and shooting taper line and those that are utilized in your area. It is also important to discuss the reasons and uses of each type which include floating, sinking, and those with a sinking tip, along with the use of leaders and why they are important.
D. Lures E. Uses	11. Lures for fly fishing are small hand tied flies and bugs. Flies are tied for specific fish and can be broken down into the categories of dry flies(floating), wet flies(sinking), nymphs(imitate underwater insects), streamers(imitate minnows), and bugs(lures made for bass and saltwater species). Use graphics and overhead transparencies to illustrate and pass examples around the class.
F. Casting Technique	12. Move the class to an area where casting can be performed. Distribute equipment. If you have an assistant, one of you can concentrate on fly casting and the other on regular casting tackle. Without an assistant, practice casting with one type of equipment at a time. First demonstrate the proper technique, and then have the students practice. Keep the group small, 3–5 students, so that they can receive individual assistance with the balance of the class watching and learning from your comments. Stress again the importance of accuracy and safety. Continue until everyone has an opportunity to utilize both types of equipment.

INTRODUCTION

Fly and casting tackle are both highly effective fishing tools for a wide variety of fish. Both are generally used by more advanced anglers since both do require a higher level of skill than do spinning or spincast tackle. Fly and casting tackle are markedly different to use, yet both can be mastered by any angler.

NARRATIVE

Casting Tackle

Casting tackle differs from spinning or spincast tackle in that the spool of the reel revolves while the cast is being made. This often results in overruns of the line during or at the end of a cast. These overruns are called backlashes and have caused many anglers to avoid this type of tackle.

Modern reels have added some new developments that help prevent this from happening, and thus make it possible for any angler to master this gear. In addition, modern lightweight materials and tooling methods have resulted in reels with light weight spools that, together with light lines, make it possible for very light lures to be cast. In some cases, casting tackle can cast lures as light as those cast with spinning tackle. Also, casting tackle can frequently be cast as far as lures cast with spinning tackle.

As with any fishing tackle, the gear should include a properly balanced and matched rod, reel, line and lure combination.

The tackle includes:

Reel

Casting reels are essentially winches, in which the spool revolves to take in line.

Frame

The frame of the reel is the part that holds the spool in place and, in turn, holds the handle and the various control levers and buttons. The frame usually consists of two side plates and several posts or pillars which connect and hold these side plates together. In some modern reels, the frame is molded in one piece, usually of a graphite fill (resin) material.

Foot

This is that small plate on the base of the reel that is used to secure the reel to the reel seat of the fishing rod.

Handle

These can be single or double grip, with the single grip usually counter balanced with a weight to prevent chattering of the reel when the handle is turned rapidly.

Star Drag

This is the brake of the reel, designed to slow the line and tire the fish as it runs with a lure.

Simple Drags

These work on the same principle as the star drag, but are controlled by turning a small knob or otherwise adjusting the braking pressure.

Cast Control

This is an adjustable knob found on the sideplate and in line with the spool axle. Adjusting it slows the reel spool during the cast. This "centrifugal" brake helps prevent overruns or backlashes. This is one of several casting control systems found on most reels and should be adjusted according to the weight of the lure or bait cast.

Magnetic Cast Control

This control is usually located on the left side plate of the reel and consists of an adjustment that controls the positioning of magnets in relation to the spool. This control helps to slow the cast at the end and to prevent backlashes. The magnets create an electromagnetic field that slows the aluminum spool or spool flange.

Free Spool Control

This can be a small push lock button or a thumb-controlled bar or lever. Either will place the reel into free spool, so that only the spool revolves during the cast.

Flipping Feature

This relatively new feature changes the reel from standard operating method to one in which line can be payed out from the reel (as in flipping, a bass fishing method not unsimilar to cane pole fishing) with the reel instantly placed into a drag or braking mode when the lever is released. Unlike the use of the thumb bar in casting, the free spool does not stay locked in place, but is dependent upon constant pressure on the bar. This control is usually found on top of or on the side of the right side plate.

Level Wind

The level wind works off a gear and pawl arrangement to cause the line to track back and forth in front of the spool and thus lay down line evenly on the spool. Level winds usually disengage when casting, and some open wide to allow for freely flowing line.

Note: Many conventional style (revolving spool) boat and trolling reels work on exactly the same principle as the above reel which is typical of fresh water and light salt water reels. Larger and more costly reels do have some differences since they lack level winds and cast controls [they are not cast anyway] and have special more sophisticated lever operated drag systems.

Rod

Casting rods differ from spinning rods in that the reel is held on top of the rod and the guides of the rod are on top. A finger grip or trigger allows for a more secure grip on the outfit. Features and parts include:

Handle

The handle consists of a reel seat to hold the reel and a grip by which the rod is held. Reel seats often clamp the reel foot in place by means of a small screw operated plate. The junction of the grip and the reel seat has a trigger for the index finger.

Guides

Small guides are located on top of the rod. Large guides are not needed since the line comes straight off the reel.

Length

Most rods range from about 5 to 6 1/2 feet although saltwater and Great Lakes downrigger rods can be as long as 8- feet. Surf rods fitted with similar but larger casting style reels will be as long as 12 feet or more.

Line

Monofilament line is almost universally used for bait casting tackle, although a few anglers do use Dacron braided line because of its low stretch. Modern reels are designed to be used with monofilament line and the mono line makes attachment of lures, baited hooks and other riggings very easy.

When using braided line, a leader of mono must be added to the end to separate the visible braided line from the fishing lure or bait.

Casting

Casting with a baitcasting outfit uses the same principles as when casting with any rod/reel outfit. The rod performs as a leaf spring to propel the lure to the target.

Set the drag on the reel so that the line will not slip. Reel in the line to within 6 inches of the tip top. Set the cast control knob on the sideplate of the reel by adjusting it until the weight of the lure will barely pull line off of the reel with the reel in free spool. For a first cast, adjust the magnetic cast control to the maximum setting (usually a high number). Turn the reel to the side so that the handles are pointing straight up for right-handed casters or straight down for left-handed casters. Place the reel in free spool by pushing down on the thumb bar or push the button release, holding the reel spool with the thumb. For best results, place the thumb in the corner of the spool and aim the tip of the rod at the target.

Casting Tackle Uses

Casting tackle is very versatile for all types of fishing. With ultralight outfits, it is possible to cast with lures as light as 1/8 ounce. Heavy outfits can be used for trolling or casting heavy 3 ounce plugs for muskie, stripers, bluefish, sharks, redfish, and barracuda. While this type of tackle is designed for casting, it can also be used for trolling, deep jigging (fishing vertically with heavy lures) and still fishing (fishing deep with bait, or bottom fishing).

Casting tackle is often the tackle of choice for fresh water bass fishing and is also good for walleye, trout, salmon, carp, and catfish. In short, except for stream trout where fly rods are used and river smallmouth where spinning tackle is often a must, due to the small lures used, there is no fresh water fish that can't be caught with casting tackle.

Casting tackle also works well for a variety of salt water angling, including just about all inshore fishing; surf, pier and jetty fishing (with specialized long, rods); fishing with bait or lures; vertical fishing over tropical reefs; and some light boat trolling. Often special rods with a longer rear grip are used for trolling or while downrigger fishing, since these will be more secure in standard boat rod holders.

Basic Lures

Lures for casting tackle include anything that is of the right weight range to be easily cast. They include topwater plugs, crankbaits, spinners, spinnerbaits, buzzbaits, in-line spinnerbaits, jigs, weed spoons, structure spoons, trolling spoons, trolling lures, worms, and soft plastics.

Fly Fishing Tackle

Line

In all other discussions of tackle, the rod or reel have been discussed first, followed by the line and lures. In this case, starting with the line is for a very definite reason. It is the line which is cast in fly casting and, as such, is important to the casting and fishing technique.

The rod is important in propelling the line. The reel is relatively unimportant except as a storage spool for extra line. However, this is not true in fly fishing for large fish since the fish is played from the reel and sturdiness and a good drag are as important as they are for any reel.

In fly fishing, the weight of the line is cast. The fly does not have any appreciable weight and is carried along with the line. This method of casting—"throwing" long loops of line back and forth in the air until the target area and distance is reached—makes fly casting markedly different than other casting methods.

Fly lines vary by their construction or shape. Since lines are made with a plastic coating over a braided core, they can be adjusted to different shapes or tapers. Lines which have the same thickness from one end to the other are called level lines. These lines are inexpensive and suitable for the beginner and simple fishing. Double taper lines are identical at each end and become thinner near the end, tapering down over a few feet to a short (several feet only) level section at the very end. Double taper lines are more expensive but do allow for the more delicate presentation of a fly since the thinner end will land more delicately on the water.

Weight forward tapers have a thick "belly" near the front of the line, a sharp taper ending with a short, level section (only a few feet), a longer taper and long thin level section (running line) at the reel end of the line. These lines, also more expensive than level lines, are best for casting larger flies and bugs longer distances. They are most often used in bass bugging and salt water fishing.

A final type of line is a short, usually 30 foot long "shooting head". This is like the weight forward, designed for long distance casting, and must be attached to a long running line of thin mono. Slight variations of all these lines by different manufacturers are common.

Lines also vary in their ability to float or sink. The vast majority are designed to float since most fly fishing is close to the surface. In addition, lines that have neutral buoyancy (suspending just under the surface), slow sinking ability, and medium and fast sinking speed are all available in most line types and styles. They allow fly fishermen to fish and reach different water depths with flies.

A final variation are those lines in which the fishing end sinks while the rest of the line floats. These are made for fishing deep, while still allowing for easy casting. A line that sinks completely is much harder to get out of the water or to pick up for a second cast than a floating line. These can also vary in the amount or length of the line that sinks.

All of these lines are labeled with the following simple code that explains these differences:

WF: weight forward
DT: double taper
L: level
ST: shooting taper
Number 3 through 12: weight of the line
F: floating
S: sinking
F/S: floating/sinking

Thus, a line label would look like any of the following examples:

WF7F: weight forward-7 weight-floating
DT4F/S: double taper-4 weight-floating/sinking
L6S: level-6 weight-sinking
ST10S: shooting taper-10 weight-sinking

The best line for most fishing is the weight forward floating line in the line size suited and matched to the rod. All fly lines are strong since they are constructed on a braided core and much stronger than the leaders that are used with them. This is why the pound test of a fly line is never listed nor important.

While most fly lines are about 100 feet long and long enough for any cast and most fishing, many anglers will add a backing to the line for insurance against long runs. The backing goes under the line and is tied to the reel at one end and the back of the fly line at the other.

Those using shooting tapers will also need a shooting line attached to the end of the shooting taper. These are similar to thin level fly lines.

Leaders

Since the thick fly line can not be threaded through the eye of a hook or fly and since it would also scare fish, a thin long mono leader is used. Most leaders are tapered, just as most lines are tapered. The tapering of the leader, from a heavy end (often about 30 pound test) to a "tippet" of one to 10 pound test (based on the fly and type of fishing), allows a smooth transition of energy to uncoil (turn over) the line/leader at the end of the cast.

Leaders vary from 7 1/2 to 12 feet for most fishing and can be bought tapered or tied at home using short lengths of standard mono. Short leaders of about three feet are used when fishing sinking lines since long leaders will prevent the fly from going deep.

Knots

Since many connections are required in the lines and leaders (backing to fly line to leader to fly), special knots are used.

Rods

Fly rods vary from other rods in many ways, though the principle of a lever or leaf spring to propel the line/lure remains the same. Because the line is cast with a fly rod, the best action is one that is often called parabolic, i.e. bending smoothly from the tip to close to the grip. Rods with fast tip or fast taper action will not cast a line well.

Fly rods vary in strength or power (corresponding to the weight of the fly line) and also length. Most rods range in length from 7 feet to 10 feet. As a result of their length, most are two piece. The reel seat is placed below the grip to keep the reel out of the way, and the rod is held so that the guides are under the rod.

Ferrule

Almost all fly rods are two piece and the joint of these parts is called a ferrule. Most rods today have ferrules built into the design of the rod blank so that parts of the blank fit together without the need for the heavier metal ferrules used in the past.

Reel Seat

These are at the very end of the rod and similar to reel seats of other rods, with the addition of a closed end or hood at the butt. An exception to this would be for larger rods that take a slide or screw in extension butt, designed to assist in fighting large fish. Many fly rod reel seats are beautifully designed with fancy wood inserts and well-made barrels and hoods.

Grip

The grip on most fly rods is of cork and in a shape that is comfortable to hold.

Hook Keeper

This is a small fixed or loose ring just above the handle and is there only to hold the hook of the fly or bug when it is not being used.

Guides

Guides are either single foot synthetic ring guides or snake guides. Various sizes and finishes are available. To aid casting, rods also have one, two or three larger ring "stripper guides" at the butt end of the rod.

Reels

Fly reels are usually simple storage spools to hold the line. Three basic styles are available. The single action reel is simply a spool in a frame. It is called single action since the handle is built on the spool; one turn of the handle causes one turn of the spool. Most fly reels are like this. The multiplying action reel is similar except that it has internal gearing so that one turn of the handle causes several turns of the spool. Most have a 2:1 or 3:1 gear ratio. The automatic reel has internal springs and gearing along with a trigger level to cause the spring to retrieve the line automatically. Rachet controls adjust the spring tension.

Reels come in different sizes to hold different size lines. Some large reels are designed for big game fishing and large fish and have highly sophisticated drag systems built in. They are more expensive than most fly reels.

Parts of a single or multiplyling action fly reel include:

Frame

This includes the rear plate and the pillars or posts holding the outer rim. The spool fits into this rim and frame.

Foot

This holds the reel on the fly rod reel seat.

Spool

The wide, narrow shape of the spool allows adequate line retrieving with the single or multiplyling reel. Single action reels also have a handle built into the edge of the spool.

Line Stripping Guides

These are nothing more than highly polished bars or a ring through which the line passes. They prevent line wear.

Drag Adjustment

Drag adjustments can include levers or knobs and can be found almost anywhere on the reel, including the spool shaft, the rear frame plate or the frame lip. It allows for adjustment of the drag that acts as a brake as the line goes out when a fish runs.

Basic Lures

Lures for fly fishing are small, hand-tied flies and bugs. Flies are tied for specific fish (trout, bass, salt water species) and can be broken down into basic categories as follows:

Dry flies are designed primarily for trout and imitate floating insects such as may flies. They float on the surface. Wet flies are soft and webby and sink. They can imitate underwater insects or land based insects (ants, crickets, etc.). Nymphs usually closely imitate underwater aquatic insects. Streamers are long flies tied on long shank hoods and imitate minnows and bait fish. Most have feathered wings. Similar style bucktails use fur in the wing.

Bugs are floating fly rod lures usually made for larger fish such as smallmouth bass, largemouth bass and many salt water species. They are most often tied with a bulky body of cork, floating plastic or rubber, and have a tail or wings of feather hackle or fur. Hair bodied bugs, hand tied of hollow hair (deer hair) so that they float are also popular among some fly rod fishermen.

Fly Casting

Fly casting does not involve the reel, but does actively involve the rod and line. To practice fly casting, one does not need a fly, but should have a leader tied to the end of the line. A fly with the hook cut off or a small knot of wool yarn works fine as a fly substitute.

Begin by assembling the reel on the fly rod. Make sure that the line guides are facing forward and the handle is on the correct (usually right) side when holding the rod. Run the line through the guides. At this point, if often helps to lay 10 or 15 feet of line/leader straight out in front of the rod.

While the principles of casting are similar to that of other tackle, the application is completely different. Some of the major differences include the following:

1. The line is cast rather than the lure.
2. The rod must pause between the two segments (front to back and back to front) of the cast.
3. Both hands are used (one for rod control, one for line control) to properly make a cast.

To cast with a fly rod, begin with the line out in front of the caster with the rod held at 9 o'clock. To make the cast, grasp the rod with one hand (usually the right hand) and the line (above the reel seat) with the other (left) hand.

To make the back cast (propelling the line to the back of the caster), both hands are used. Raise the rod to a 1 o'clock position, gradually accelerating the rod and stopping smoothly, but abruptly, at 1 o'clock. At the same time, pull back on the line with the other hand to accelerate the line and help make the cast. Pause at this point in the cast. Properly done, the line will flow back in a smooth loop or arc until straight behind.

At this point, begin moving the rod forward, again gradually accelerating as the rod is pushed forward through the air, changing the position of the rod from 1 o'clock to 11 o'clock. Push the rod forward until the hand is completely extended, then turn the rod down (to a 9 o'clock position) to make the loop of line to open and turn over, causing the line to float down and the fly or bug to land delicately on the water.

As the rod comes down to a fishing position and the line straightens out, release any slack line from the line hand to increase casting distance. Once the fly has landed, keep the hand on the line to begin retrieving.

Common faults of beginners include the following:

1. Bringing the rod back too far. This will drive the line down on the ground or water and "kill" the backcast.
2. Bringing the rod forward before the loop of the backcast has properly opened up. This will not allow the energy of the forward cast to propel the line and will cause a "crack the whip" effect.
3. Not accelerating properly during the backcast or forward cast. An even rod movement will cause a wide line loop which will not allow maximum distance or accuracy.

LESSON 10

Terminal Tackle, Baits, Lines, Knots and Hooks

LESSON
10

Terminal Tackle, Baits, Lines, Knots and Hooks

Lesson Objectives

Following this lesson students will:

1. Know what terminal tackle is, its purpose, and how to use it.
2. Know the important characteristics of fishing line.
3. Be able to tie several fishing knots.
4. Know how to select hooks for fishing.
5. Be aware of basic salt and fresh water baits and how to hook and use them.
6. Know how to sharpen hooks.
7. Have a basic understanding of chumming.

Materials for the Lesson

1. Examples of several different types of line. Individual spools of monofilament for each student or at least enough so that each student can be supplied with enough line to tie several knots.
2. Knot and hook booklets, ordered from companies in the appendix.
3. Several 5' lengths of clothesline rope, enough for students to be paired to practice knot tying.
4. Several large eye bolts to simulate the eye of a hook for knot tying.
5. Examples of the many sizes, styes, shapes, and finishes of hooks.
6. Files and hones to demonstrate hook sharpening. Very large hooks for same purpose. Several pairs of needle nose pliers to hold hooks during sharpening.
7. Examples of bait used in your area.
8. Photocopies and overhead transparencies of appropriate graphics from the appendix.

Much of this lesson will be "hands on" work for the students. If your class is large, the use of a volunteer is suggested to assist students with tying knots and hook sharpening. Again, stress safe handling of the hooks.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	1. Introduce students to the lesson objectives. of the lesson.
II. Terminal Tackle, Lines, and Knots A. Basic Principles B. Terminal Knots C. Line to Line Knots D. Specialty Knots E. Splices	2. Lead a brief class discussion concerning the items classified as terminal tackle and the importance of these items in fishing. The students should understand that these items determine whether or not a hooked fish is landed. The importance of sharp hooks, good swivels or snaps, quality line and well tied knots cannot be overestimated. 3. Discuss the characteristics of good fishing line. Line is the only connection between the angler and the fish. Good quality line will make fishing a more pleasant experience and will increase the percentage of hooked fish that are landed. Monofilament line is the most widely used today, but there are numerous special lines including dacron, wire, lead core, fly line, and "line class" line. If your class is young or inexperienced, concentrate on the monofilament. If it includes experienced anglers, discuss specific others based on their needs and local use. 4. Distribute the lengths of rope, monofilament line, eye bolts, pliers, and photocopies of those knots that will be learned. Using your transparency and a length of line demonstrate how to tie the clinch knot. After the students can tie this knot, move to the improved clinch. After practicing with the rope, have each student tie these knots with monofilament line directly onto a regular hook. With advanced students several other knots of your choice can now be taught. The blood knot can also be taught to beginning students. This knot is used to join two pieces of monofilament together. Encourage students to practice these and other knots shown in the booklets received from the manufacturers.
III. Hooks and Bait A. Hooks and Sizes B. Hook Parts	5. Using the photocopies and the overhead transparencies, discuss fish hooks. The different sizes of hooks should be noted for use with different species and sizes of fish. Distribute single, double, and treble hooks and discuss how these can be used to hold bait or on artificial lures. Again, using the visual aids discuss the parts of a hook and that different styles of hooks differ in some of these areas.

Lesson Content Outline	Classroom Procedure
C. Sharpening Hooks	6. Distribute hook files and hones. Discuss the importance of using sharp hooks and the fact that most hooks need to be sharpened before being used. Show students how to determine if a hook is sharp. Tell them to carefully scrap their fingernail with one of their hooks. Dull hooks will slide easily across the nail, but sharp hooks will begin to penetrate the nail with very little effort. Discuss hook sharpening using the overhead and then demonstrate. Hold a hook with the needle nose pliers, sharpen one side of the hook and then the other. After filing both sides, sharpen the bottom of the hook. This provides a very sharp hook. Have students test their sharpened hook on their fingernail. Caution them to be very careful.
D. Bait 1. Fresh Water 2. Salt Water 3. Attaching Bait	7. Lead a brief discussion of common fresh and salt water baits utilized in your area. These can include live or prepared baits such as dough balls or corn. Discuss the importance of using bait that is similar to the food that the fish normally eats. Distribute the baits that you brought to class one at a time. As each is distributed, demonstrate methods of attaching it to the hook and then let students practice. Worms, minnows, hellgrammites, insects, doughballs, and others are suggested for use. If salt water fishing is popular in your area clams, shrimp, mussels, and others can be utilized.
E. Chumming	8. Explain to students that fish utilize their senses of smell, sight, and sound to located their bait. For those fish that rely heavily on their sense of smell, chumming is often used to attract them to the bait. Chumming is spreading finely ground bait in a fishing area. This works well where there is a slow current or a tide. However, check local fishing regulations since chumming may be prohibited.

INTRODUCTION

No matter how good, expensive, or expertly used a rod and reel are, the fishing equipment is only as good as the combination of line, sinker, float, hook, lure and/or bait. The simplest error, such as the wrong hook, improper hook size, dull hook point, wrong size line, incorrect sinker or poor rigging can result in no fish and a poor fishing experience. Equally important as the selection of this terminal tackle is the understanding of these choices of tackle and why different lines, hooks, floats, sinkers and rigs are used.

Good knot tying procedures are also important since a poorly tied knot will be too weak. A few good knots must be mastered in the areas of line-to-line connections, making up rigs, line-to-lure (or hook) connections, along with some specialty knots.

Just as hooks and terminal tackle are important, so is the proper bait and its use for all types of fishing. Some baits are used whole, and others are prepared or cut up for the best fishing success.

Chumming is a technique used in many fresh and salt water fishing situations to help attract fish to the bait and hook although it is illegal in some areas and for some types of fishing. Chumming basically involves the use of fish food parts or ground up attractant to attract game fish.

NARRATIVE

Lines, Knots and Connections

It is obvious that fishing line is the only connection between the angler and the hooked fish. Fishing line must be strong, thin, have good shock strength, good tensile strength, good knot strength, be limp to cast properly, and hopefully, be invisible to the fish.

These characteristics are best suited by monofilament nylon fishing line, by far the most widely used line available today for all fishing. Mono, as it is called by most fishermen, has all the good line characteristics listed above. It is ideal for almost all casting, trolling, still fishing, drifting and other fishing using boat, trolling, surf, spinning, spincast and casting tackle.

Other lines are also available, including braided Dacron line, often used for trolling for big game or when little line stretch is desired. Dacron line has very little stretch and as a braided line, it is conducive to simple splices. However, it does not have good knot strength when using the same knots that work well for mono. Thus, special knots must be used.

Wire line has virtually no stretch. Single strand wire is used for deep trolling since it will get a lure down deeper than other lines. It must be handled carefully as it will kink and weaken. It will not knot, and special twists and splices must be used for connections.

All line comes in varying strengths (test) and spool sizes. Strengths can vary from as little as one pound test up to 200 pound test line. Typical "tests" for monofilament would include 2 through 200, with 6–20 probably the most popular. In addition, some heavier tests are also used, but primarily for specialty fishing or as leaders for big game fishing.

Spool sizes range from little 100 yard spools to large service spools of 6,000 or more yards. The latter are primarily used by stores for filling customers' reels, or by heavy users, such as clubs, record seeking fishermen (who often change line with each fish caught) or big game anglers. Most anglers use spools containing 250 to 600 yards of line. Most line used by fishermen is guaranteed to break at no less than the line strength marked on the package, although "class line" is different.

Some anglers like to fish for record fish, usually in "line classes" specified by the International Game Fish Association or a similar group or cooperating tournament. Line samples must be submitted when records are entered. A line too heavy for one class will push that entry into the next higher class. Thus, a 20 pound "class" line for use in a 20 pound record category can not test more than 20 pounds wet strength. Thus, all "class" line is slightly weaker than the label listing.

Line color is also important to prevent the fish from spotting the line. Most monofilament lines are designed to "disappear" in the water, although the best color or shade is the subject of much debate. Water, bottom and turbidity conditions can also affect the color choice. Some bright colored lines are popular, primarily because they can be seen by the angler. Bright lines are best seen and used by surf, boat and trolling anglers since the line helps to indicate the position or location of the bait.

Wire lines cannot be made transparent or translucent as can mono, but often wire lines or leaders are chemically treated to make them black, brown or coffee colored, rather than the bright wire color. Also, mono leaders are often used between the wire line and the lure or bait. Braided lines, such as Dacron, can be seen but, as with wire lines, are often used with mono leaders, both for knot tying ease and for their relative invisibility.

Fly lines are completely different because the line is not designed for strength, instead for a weight and diameter that allows casting. Fly casting is really fly line casting, with the fly carried by the line. Fly lines are strong since they are made of PVC plastic on a braided core that usually tests about 30 to 40 pounds. The lines come in level, double tapered, and weight forward styles. The double taper has a thick center section, or belly, that tapers at each end. The weight forward taper has front taper, short belly and long thin level rear section of line. Fly lines can be bought in floating, slow sinking, moderate sinking and fast sinking types, with specialty lines also available for certain fishing applications. Most lines are about 30 yards long. For more details, see Lesson IX.

Tackle Selection—Casting and Fly Outfits

Leaders are often used in fishing. A leader is nothing more than a short length of connecting material between the line and the lure or hook. Leaders are used with fly lines to keep fish from seeing the heavy, thick fly line. Also, fly line is too thick to thread through any fly. The tapered leaders also help to transmit the energy of the cast to properly straighten (or "turn over") the fly for presentation to the fish.

Mono leaders used with Dacron line or wire line help to separate the line from the lure. Mono leaders are used for the same reason, even when fishing with mono line if a trolling sinker, planer (diving plane), downrigger or other gear is used.

Shock leaders are heavy leaders used to prevent fish from cutting off or breaking off or to protect against the strain of a forceful cast. Originally meant as a leader to prevent line breakage on a surf cast, these leaders can be of heavy mono, wire, or braided wire and range from several inches to many feet long. To prevent cutoffs, they are used for bluefish, pike, barracuda and similar species. To prevent fish from rubbing or wearing off, they are used when fishing for billfish (marlin, and sailfish), whose bills can run through a light line and for species such as shark which frequently rub their rough bodies against a leader or roll up in it.

Terminal knots are used to tie a line or leader to a hook or lure. Good knots must be easy to tie, have a knot strength that approaches the strength of the line (90 percent or higher), and hold without slipping. Good knots for line-to-hook fastening include the improved clinch knot, the palomar knot, the Trilene knot and the uni-knot system.

Line-to-line connections (knots) are required when making tapered fly leaders, tying shock leaders to line, tying fly line to leaders, tying fly line or other line to backing line and similar connections. Good knots must be easy to tie, small (to flow through guides if required), and strong. Good connections include the blood knot and the uni-knot system.

Specialty knots include those in which some special characteristic is required, such as a loop knot to allow lures to move freely, a knot to connect heavy shock leader to light line, and knots that must be 100 percent strong for record and light tackle fishing. Loop knots do not generally have good knot strength but are easy to tie when using the Uni-knot, Rapala knot, or Homer Rhodes loop knot. Connecting lines of dissimilar thickness is difficult; however, the Albright and surgeons knots are two examples that work. 100 percent knots include the Spider hitch and the Bimini twist, with the Bimini the surer knot.

Splices are necessary with wire and are often used with braided line. With the hollow braided line, a special splicing needle is used to make splices to connect lines and make loops. Wire requires special loops and twists, including the figure 8 and haywire twist for terminal connections.

Hooks

Hooks have one purpose—to hook and hold the fish. There is an almost endless variation of sizes, added bait fasteners, point styles, bend types, shank shapes, shank lengths, wire thicknesses, eye types and finishes. Popular styles have names such as Perfect, Kirby, Carlisle, Sprout, O'Shaughnessy, and Aberdeen, in addition to manufacturers stock numbers.

Basically, hooks come in single, double and triple (treble) points. They come in a number of basic styles, with each style having a special name or stock number by which it is known. Hook sizes seem confusing but range from size 22 (very small for fly tying) through size 1 in even sizes (22, 20, 18, 16, 14, 12, 10, 8, 6, 4, 2, and 1), and then in larger sizes, from 1/0 (smallest of the /0 sizes) through size 16/0 in both odd and even sizes. Each particular style of hook has its own shape, shank thickness, shank length and point style, with changes in hook sizes incrementally and proportionally changing these dimensions.

In addition, there are hook variations as follows: *Points* can be straight or curved, barbed or barbless (for use on special waters where these are required). *Bends* vary from the half round shape (perfect) through odd shapes, often characteristic of a particular name of hook. Bends, usually forged, can also be twisted sideways so that the point is not in line with the shank, such as the kirbed bend (pointing left with the hook up and facing the angler) and reversed or offset (bent in the opposite direction). In addition, some modern hooks have similar offsetting bends in the shank that cause a turning or camming movement (for better hooking) when in the fish's mouth for better hooking. ***Shanks*** can be round or flattened slightly and forged in the bend for strength. Shanks can also be shorter or longer or stouter or thinner for a given style of hook.

Eyes can be ball (a round eye), tapered (used primarily for fly fishing in which the wire of the eye is tapered), looped (looped back on itself and used for salmon hooks), and needle eye (formed in the shank for high strength and used for offshore, big game hooks). Some styles used for snelled hooks (hooks fastened to a short length of mono for adding to a bottom rig) do not even have eyes, instead have a ball or swelling on the end of the hook shank to prevent line slippage. *Bait holders* on hooks vary widely. Some include springs on treble hooks and safety pins on single and double hooks. The most common are slices on the shank of single hooks to prevent bait slippage. Finishes on hooks vary from bronzed to black to blue and special finishes such as nickel and cadmium plating. Some hooks for salt water use are solid stainless steel to prevent or reduce corrosion problems. Stainless steel hooks are up to 25% weaker per wire diameter than carbon steel hooks and can kill a fish if breakoff occurs.

Special hooks include almost round shaped tuna hooks, large triangular style hooks for pike, and long shank, needle eye double hooks designed to be threaded through a baitfish or minnow.

Some hooks today are chemically sharpened or rotary honed by the manufacturer. However, all hooks become dull and must be sharpened. Curved point hooks must be sharpened with a round or half round file or stone. Hooks with straight points should be sharpened with a flat stone or file, flattening both sides and the base into a triangular shape for easiest penetration with maximum strength. Special hand files, stones and diamond embedded sharpeners are available for field use, with electric sharpeners made for home use. Sharpening should be carefully done since all hooks can be dangerous.

Bait

Baits can consist of live animals (in the biological sense including worms, crickets, and minnows), dead or cut up baits, nontraditional baits (not normally eaten by fish and including corn and dough balls), and prepared baits. To be effective, baits must reflect the natural foods of the fish sought. Thus, insects are often used for trout, minnows and frogs for bass, and dough balls and corn for bottom feeders such as carp and catfish. Baits can range in size from a tiny insect threaded on a hook to a large, two foot long Spanish mackerel for trolling for big game marlin.

Typically, baits and their preparation can be broken down into fresh or salt water as follows:

Freshwater Baits

Worms of all sizes are used for fishing since most fish will eat them. Worms range in size from large night crawlers to small manure worms. To be effective as bait, worms must be kept cool and moist, but not wet. In most cases, a single worm is best threaded back and forth on the hook. Small fish are best taken using a small hook and only a piece of worm, while large fish are best attracted by several worms or multiple hooks, each with a worm.

Minnows are available at most bait shops or can be seined easily in most waters. Check local regulations—usually a fishing license is required and some waters may be prohibited for minnow seining or trapping. Minnows include various chubs, daces, shiners, and other species. A minnow bucket is a must to keep minnows for fishing. Hooking methods include running the hook through the lips, hooking through the back at the dorsal fin, and running the line through the mouth/gills with the hook in the tail. Dead minnows are often fished with the hook run through the body while trolled minnows are often wrapped or sewn on the hook.

Water insects such as hellgrammites, larvae of caddis and mayflies are also good bait. *Hellgrammites* are hooked through a thorax collar. *Land insects* are also hooked once through the body or wired on the hook using very fine copper wire. Typical insect bait includes grasshoppers, crickets, various grubs and maggots, gall worms and caterpillars. *Crayfish* are also good bait, especially for trout and smallmouth bass. Good hooking methods include hooking through the tail or just using the tail as bait. *Frogs* were previously widely used for bass, hooked through the lips, through one leg, or held in a special frog harness. *Fish eggs* are often used for trout, steelhead, and salmon. Salmon and steelhead eggs are also used, either singly on a tiny hook or wrapped in a small cheese cloth bag around a treble hook.

Other baits for fresh water fishing include leeches, hooked through the lips for walleye; dough balls and kernel corn for carp; clams and mussels for catfish and carp; and cut bait consisting of cut up fish parts for bottom feeding game fish.

Salt Water Baits

Sea worms can't be gathered but are imported from northern coastal areas and include blood worms and clam worms. They are used whole or in pieces on a hook and can bite, requiring caution to hook. They are good for almost all inshore salt water game fish. *Clams, mussels,* and *scallops* are good baits for perch, drum, sea trout, and rockfish. They are completely removed from their shell and threaded onto the hook. Small cut up pieces of the clam are used on smaller hooks for small fish. *Welks and conchs* are used as bait in southern climates in cut up pieces as bait for tropical fish including permit, bonefish, snapper and grouper. *Squid* can be used whole, sewn onto a hook as a trolling bait for big game fish, or cut into small pieces to be threaded onto a small hook as bait for smaller inshore fish. Strips of squid are also used for trolling and bottom fishing. Octopus is used in a similar fashion. *Crabs* are used whole when fishing for tarpon, drum, and blackfish, or can be cut into small pieces (usually quartered) for fishing for smaller fish. Small pieces of legs of shedder or soft crabs are also used for small fish. *Shrimp* can be used live or dead, hooked through the tail, or cut up into small pieces and threaded on a hook, after the shell is peeled off to make it more attractive. Baitfish and minnows include mullet, killifish, menhaden, herring, Pacific sardines, and other similar species, which are usually hooked through the lips, sewn onto a hook, or cut up into pieces for use as bait. Menhaden are typically cut into chunks for bottom fishing or into strips for casting, trolling and drifting. Large baits for trolling include anything from mackerel to Spanish mackerel, dolphin (the fish), blue runners, white perch, albacore, belly hoo, needlefish and other ocean species.

Chumming is a method of broadcasting finely ground bait or attractant in a fishing area in an effort to attract fish. Chumming is done in both fresh and salt water, but be sure to check regulations before trying this method. At this writing, a half dozen states prohibit chumming. Other states do not allow chumming on "lure only" or "fly fishing only" waters, even when lures—not bait—are used to catch the fish.

The purpose of chumming is not to feed the fish, but to attract them; thus most chum is finely ground up or mixed with a filler of grain or oatmeal to spread the bait. Typical chum could include scattered corn or a doughball before or when fishing for carp or catfish, ground up clams for fishing for striped bass, or ground up menhaden to lay down an oil slick to attract bluefish. Some bass fishermen are even using the currently popular scents as a "chum" to attract fish or make them more interested in feeding.

Good chumming usually takes place in still waters for bottom feeders or waters with a slow current or tide to attract fish to the fishermen. If working with a current or tide, a constant release of chum is necessary. Any break in this release will interrupt the scent trail (back to the anglers) that the fish follow.

Best baits include the same baits as the ground up chum, although some anglers will use a chum to attract the fish, taking the fish on lures or flies. The most effective fishing is with a bait drifted in with the chum line.

LESSON 11

Lures

LESSON

11

Lures

Lesson Objectives

Following this lesson students will:

1. Recognize different types of fishing lures.
2. Understand the role of action, color, scent, size and pattern in lures.
3. Understand the response of fish to lures; aggressive, feeding, protective, and reacting.
4. Understand how to fish lures effectively.
5. Know how to store fishing lures.

Materials for the Lesson

1. A number of different lures including plugs, spinners, spinnerbaits, buzzbaits, plastics, jigs, spoons, flies, and any others locally popular.
2. There are numerous graphics of lures in the appendix. Have photocopies of several available to distribute to students as well as overhead transparencies for your use.
3. If possible, have a tackle box arranged with shallow running baits in the top shelf and bottom baits in the lower shelves, with medium depth baits in between.
4. Sufficient quantities of lure catalogs from several companies so that students can each keep at least one.
5. Photocopies and overhead transparency of tackle box organization.
6. An aquarium filled with water if possible or, if available, much of this lesson could be taught at a swimming pool.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	An easy way to organize this lesson on lures is to begin with those utilized as surface lures and progress down through shallow and medium runners, to deep divers, to those effectively utilized on the bottom. Basically, this is also an efficient method of organizing a tackle box, and as various lures are discussed students can be shown the lure's place in the box. It would be prudent to remove the hooks from any lures that will be handled by the students, especially beginning or younger anglers. 1. Introduce students to the lesson objectives.
II. Artificial Lures A. Plugs B. Spinners C. Spinnerbaits D. Buzzbaits E. Soft Plastics F. Jigs G. Spoons H. Flies, Bugs	2. Ask students why we use artificial lures. Write their responses on the chalkboard. Discuss how they are designed to take the place of natural bait and can be made of many different materials. Most lures have a built-in action, but some must be manipulated by the angler. 3. Utilizing the photocopied graphics and the overhead transparencies, lead a classroom discussion on the general categories of artificial lures, especially the ones most popular in your area. For introductory or younger, inexperienced anglers, concentrate on only a few. Advanced anglers can benefit from a thorough discussion of jigs, spoons, and fly fishing lures, not often utilized by younger anglers. 4. As these lures are discussed, demonstrate their action in an aquarium, if one is available. Also bring color, scent, and size into the discussion. 5. Stress safety in the handling of lures and while fishing. Let students feel a sharpened hook, under supervision. Otherwise use lures with no hooks or those whose hooks have been covered with tape, corks or some other protective material.
III. Other Lures A. Miscellaneous Lures B. Scents for Lures C. Lights and Colors D. Prepared Baits	6. Show some lures that do not fit neatly into one of the general lure categories. These lures might incorporate a spoon, spinner, or propellor with a floating body, or combine spoons and spinnerbaits. These lures are often designed to fill a specific fishing need, and often may be popular in a limited geographic area.

Lesson Content Outline	Classroom Procedure
IV. How to Fish Lures A. How to Fish Lures B. Methods of Working Lures C. Feeding and Strike Response	7. Some anglers utilize some type of prepared bait or commercially available bait to enhance their lures. Discuss the use of pieces of fish, minnows, pork rind, etc. to appeal to the fishes' senses of taste or smell. Ask students if they have ever done this. 8. Ask students if they have fished with artificial lures. Have them explain how they utilized them to lead into a discussion of effective methods of working lures in still as well as moving water; how fish strike lures; and what to do when a fish strikes.
V. Tackle Boxes	9. Utilize the photocopied handouts and overhead transparencies, along with a tackle box that you brought, to again stress how a tackle box should be organized. Discuss the different sizes and styles for differing needs and sizes of lures for different species of fish. It is also important to stress keeping different colors of soft plastic lures in different compartments from each other and from other types of lures. Their colors will bleed onto others. Also discuss the importance of keeping lures dry so that rust does not damage the hooks. Lures should be dried before storing to prevent this from happening. 10. Distribute the lure catalogs to the students. Enough should be available so that every student can keep at least one.

INTRODUCTION

This lesson is designed to introduce the class to all types of lures and the reasons for their use. Safety when handling lures is emphasized and will decrease the possibility of accidents.

Emphasize that a lure is only as good as the angler fishing it and that care and proper lure manipulation must be used to be successful in this type of fishing.

NARRATIVE

Artificial Lures

Artificial lures have been around almost as long as man has fished. Artificial lures are designed to take the place of natural bait in catching fish. They include those made of metal, wood, hard plastic, soft plastic, and lead. Unlike much bait, which can be allowed to drift in the current, lay on the bottom, or be dragged through the water, lures must have some action to simulate a natural bait or to attract a fish to strike. Some lures have a built in action, while other lures must be carefully manipulated by the angler.

Basic Artificial Lures—Plugs

Sometimes called crankbaits, these hard wood or molded plastic lures are usually designed through size, shape and action to simulate a baitfish or aquatic food. A variety of plugs is available for all kinds of fishing in fresh and salt water. Freshwater plugs are generally small, while salt water plugs are usually larger for the large fish caught.

Freshwater plugs have color patterns that imitate fresh water bait, usually in a large variety of natural colors, although plugs used in the Great Lakes area for salmon and trout are typically in gaudy fluorescent colors. Salt water plugs are available in fewer colors. Blues, golds, and bright shiny chrome plated finishes are popular. As is true in freshwater, some salt water lures are solid colors while others are patterned or printed to resemble a salt water bait fish.

Different types of plugs are designed for specific purposes. Surface plugs often have special plates or cupped faces to create action, while diving plugs have lips which force them to dive under water and control their depth.

How deep plugs can be fished depends upon the bill or lip design (short lips dive shallow, long lips dive deep) and whether the plug is a floating or sinking model. Most plugs can be used for both casting and trolling. Some top water plugs are designed only for casting while some specialized plugs are built only for trolling. Plugs range in size from tiny one-inch long 1/8 ounce models to large saltwater and musky models of over a foot in length.

Basic Artificial Lures—Spinners

Spinners are usually metal lures built so that a spinning or rotating blade revolves around a central shaft holding the body and the hook. While completely metallic spinners are common, many today are also equipped with fur or feather hook dressings or have the addition of other items such as soft plastic minnows, grubs, and plastic tails. All of the parts are in line on a single wire shaft.

Spinners also range in size from very small (1 1/2" or 1/12 oz) to large musky models (7–9" and 1 to 1 1/2 oz). Spinners are almost exclusively used in fresh water and cast by the angler. A similar spinner style with a weighted head to get down to the bottom is widely used for walleye fishing.

Basic Artificial Lures—Spinnerbaits

Spinnerbaits are basically bass fishing lures. A round or tapered lead head is molded on a spring safety pin wire form with a single hook in the lead head. One or more spinner blades are attached to the arm and a skirt or tail is added to the lead head. They are for casting and can be fished from the surface to the bottom. They come in a variety of colors and blade finishes in single blade or double blade (side by side or in line) styles. A similar lure fitted with a tail of soft plastic or capable of holding bait is commonly used when fishing the bottom for walleyes.

Basic Artificial Lures—Buzzbaits

These bass fishing lures are like spinnerbaits except that they are made in a J shape with a single or double propellor blade attached to the upper arm to create a surface disturbance. As with spinnerbaits, they are equipped with skirts and come in a wide variety of colors, sizes and styles.

Basic Artificial Lures—Soft Plastics

Soft plastic lures were originally designed for bass fishing and were made in the shape of a worm. Today, thousands of sizes, shapes, lengths, styles and colors of worms are available in addition to other soft plastic lures. Other lures include those for all fresh water fishing (frogs, minnows, insects, leeches, and eels) and salt water lures (grubs, shrimp, crabs, minnows, eels, mullet, and squid).

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These soft plastic baits can be rigged (sold with a hook and ready to use) or unrigged (fitted with a hook by the angler), cast or trolled, and made of a firm or very soft plastic. These lures do not have any built-in action and must be manipulated by the angler to work properly.

Basic Artificial Lures—Jigs

Jigs are widely used in both fresh and salt water fishing. They are heavy-headed lures, usually lead, into which a hook is molded. Traditional jigs have a skirt of fur, feather or both, although modern jigs often consist of just the bare, painted head fitted with a soft plastic tail or body. As with the soft plastics, these do not have any built-in action, thus must be manipulated by working the rod to create a bait-like movement in the water.

Basic Artificial Lures—Spoons

Spoons can be divided into three basic categories. Fresh water spoons are thin bladed and designed for casting or occasionally for trolling. They might have a fixed (stationary) single hook or a free swinging hook. Dozens of colors, styles and sizes are available, ranging from tiny one-inch long blades up to huge (10″ and 1 1/2 oz) models. Some for bass fishing are fitted with weed guards (wire, plastic or nylon protectors over a fixed, single hook to prevent weeds from catching on the hook) so that they can be fished in heavy weeds without snagging or picking up weeds.

Structure or jigging spoons typically are slim shaped and heavy bladed to sink rapidly. They have free swinging hooks and are designed to be worked on the bottom by lowering the spoon to the fishing area, then working the spoon up and down in a jigging action. Both fresh and salt water models are available.

Trolling spoons are large, usually thin bladed spoons with a single hook designed to be trolled (trailed) behind a boat. They have a built-in action caused by their movement through the water.

Basic Artificial Lures—Flies

Flies for fishing with a fly rod are hand-tied and are constructed on a bare hook using synthetic and natural (often very exotic) materials. Many fishermen tie flies for a hobby, but commercially tied flies and bugs are also available. The materials used include thread, feathers, fur, wool, nylon, tinsel, Mylar, and chenille. Exotic materials include such things as Jungle Cock, Golden pheasant, bustard, and peacock herl, but do not include endangered or threatened species.

Flies are tied primarily for trout fishing, but are also often used for bass, panfish, and salt water species such as tarpon, bonefish, and snook.

Typical fly styles include streamers and bucktails, both imitating a minnow in their length and design; wet flies and nymphs imitating aquatic insects; and dry flies imitating floating aquatic insects, such as may flies.

In addition to flies, floating bugs are also used for fly fishing, primarily for bass, panfish and salt water species. These bugs are made of cork, plastic foam, or tied with floating deer hair.

Miscellaneous Lures

Some lures defy categories. These lures combine the various elements of several basic types. They can include a spoon, spinner, or propellor blade with a floating plug body or may combine spoons and spinnerbaits, jigs and spinners, spinners and spoons, and flies with spinners, jigs, spoons, and plugs. In addition, many lures will incorporate a soft plastic tail or grub, although these are most often found in spinners, spinnerbaits, spoons, and jigs.

Lures are specifically designed to fill a specific fishing need. In most cases they are loosely placed in the category that seems to best suit the lure purpose and design.

Factors in Lure Design and Lure Choice

A number of factors are considered by manufacturers in any lure design. These include the intended quarry since no lure will work for every fish. The size of the fish and what and how it eats must be considered. Since most lures are based on the feeding response of the fish, eating habits are predominant in choosing the basic size, shape, design, action, color, flash, pattern and fishing depth of the lure.

COLOR—Color is important in attracting fish, and recent electronic equipment helps fishermen determine the most visible color lure at various depths and water conditions.

In some cases, bright colors are important, as in the bright fluorescent colors used in some salt water fishing and almost universally in Great Lakes trolling for trout and salmon. In other cases, as when fishing for river smallmouth bass which feed primarily on black hellgrammites and brown crayfish, black and brown are often utilized. Typically, colors will closely resemble the baitfish eaten by the fish.

Colors can be too bright or too dark. Bright flashy metallic spoons and spinners are often too flashy for crystal clear water, though a black lure or spoon will often show up best in cloudy or muddy waters. Spinners and spoons typically have metal parts available in nickel, copper, brass, gold or black, although painted color blades are also available.

Jigs are painted, usually in simple primary colors. Cork and foam bass bugs are painted, but the color of flies is determined by the choice of materials used to tie them.

Action

Some lures have built in action when the lure is retrieved; others do not. Those that typically have a built in action include plugs, spinners, spinnerbaits, buzzbaits and spoons. The plugs and spoons have a wobbling action because of their design, while the spinners, spinnerbaits, and buzzbaits have a straight movement with action occuring in their spinner parts and rotating blades.

Lures that do not have any intrinsic action or movement include jigs, soft plastics, flies and bugs. There are exceptions to the above since some surface plugs have no action while some jigs have action in their skirts or attached spinner blades. Soft plastic lures with curly or minnow-like action tails seem to "swim" in the water.

Pattern

At one time, many lures (mostly plugs) were made through a photoprint method that allowed very close imitation of a natural forage coloration and pattern. Most patterns or finish styles in lures are only suggestive of a bait fish, although natural patterns as well as simple, one color finishes are also common.

Size

Size of the lure must be based on the size of the quarry and also the size of the food they normally eat. For example, a large smallmouth bass in a lake might be receptive to a large plug or crankbait that imitates a large bait fish, while a small fish in a river would be more likely to hit a small lure imitative of a small crayfish. The same concept applies to all fishing, but some fish will take markedly different sized lures than another species of the same size, based on their different feeding habits.

Scent

Scent has recently become very important as a fishing lure additive for all types of game fish. All fish have olfactory glands and are able to smell. Salmon and eels can smell far more acutely than many other species. The importance of this sense in fishing varies with the species. Species such as catfish, carp, bonefish, and bluefish use scent to find food. Other species, while using this scent, rely more on sight and sound.

Fresh and saltwater scents are available. Such scents are generic or of a specific smell such as shrimp, shad, crayfish, or mullet. Scents are popular additives to all types of lures but are best when used with lures that are moved slowly, such as jigs, soft plastics, and flies. Scents can damage some lures when used over a long period of time and can damage some other fishing related items such as boat carpeting. Scents are not legal in some states and fishing areas, so be sure and check before using.

Light

Light in lures through small chemical lights, or phosphorescent additives is also becoming popular. The chemical lights are activated before fishing, while the phosphorescent lures are "charged" by light. Most are built into the lure.

Lure and Bait Combinations

Often lures and bait are combined for added attraction in catching fish. Almost any type of bait can be added to a lure or the lure hook, provided that it will not impede the action of the lure and provided that it will stay on the hook. Bait can be added to attain more action, such as a strip of fish or pork rind, or added to attract fish by taste and smell, minnows to a jig, clams to jigging spoon, or a frog to a weedless spoon. There are no right or wrong ways to use bait other than what works best, which baits are available, and what is legal.

Methods of Fishing with Lures

Bait fishing usually involves casting a bait and letting it drift through the current or rest on the bottom until a fish picks it up. To attract fish, even if modified with scents or bait, a lure must be moved. Moving the lure can be done by casting and retrieving (as in still water), letting the lure tumble and swim with the current (as in fishing a salt water tidal flow or fresh water river), or trolled from a boat.

Some lures have a built in action so that the lure can be cast and simply retrieved to catch fish. This applies to plugs, spinners, spinnerbaits, buzzbaits, and spoons. Soft plastic-worms in particular-and jigs must be manipulated by the angler to have action. This action is usually best accomplished by sharply jerking the rod up or sideways or by moving the rod in long sweeps to make the lure swim, hop along the bottom, spring up off of the bottom, or act in a natural, lifelike way.

One other difference in working with lures vs bait is in how the fish reacts. Usually a fish taking a bait will carefully mouth the bait. Every fish species varies in the reaction time and much of the success of bait fishing is in interpreting these signals by the fish and reacting properly. Fish usually hit lures rapidly and savagely, although they will carefully pick up soft plastic lures, or in salt water, sharply knock a trolling lure so that it can be picked up when "dead" in the water.

Since lures generally move more rapidly than bait, fish apparently strike rapidly to keep it from getting away. Most strikes are a feeding response. This occurs with almost all fish in almost all fishing conditions. When fish are spawning, they might strike a lure to protect their young and to remove the intruding lure from the spawning bed or young. They will also strike aggressively, presumably to keep other fish from getting the lure, almost like a dog will eating food it does not want to keep another dog from getting it. Fish that apparently do not feed will also strike reflexively, such as American shad or Atlantic salmon striking flies and lures while ascending rivers to spawn, even though they do not feed during this time.

Fishing Lure Storage

Fishing lures should be kept organized. Some sort of tackle box, lure box, or fly book must be used. Tackle boxes come in many styles, including those that look like tool boxes, those with a hip roof (both sides of the top open), and single or double side "satchel" boxes that look like and are carried like brief cases.

Most of these boxes come in several sizes and in styles for specific fishing methods. Thus, boxes designed just for large (musky, lake trout, or salt water) lures, for spinnerbaits, for jigs and pork rind, and for plugs can be found.

In addition, there are small single compartment lure boxes in various sizes to hold lures. Fly boxes are made the same way, but these also include synthetic or lamb's wool books to hold flies. Bugs are usually stored in some type of lure box or specialty bug box.

A system to store lures assists the angler in finding them easily. Many anglers store lures in trays by category (plugs, spinners, jigs) and will further divide these lures by sub-types (top water plugs, minnow like plugs, medium running plugs, deep running plugs).

Lures should be kept separate in tackle boxes, and boxes designed for soft plastics are available. Soft plastics contain chemicals that will harm many plastics. Most tackle boxes currently made are designed for these lures, thus are "worm proof". It is equally important to keep soft plastic lures from hard plastic and painted lures in order to prevent chemical reactions that can ruin lures. Similarly, if fishing with soft plastics, different colored lures should be separated to prevent bleeding of one lure color into another.

After fishing, be sure to check lures to prevent rust. If the tackle box becomes wet or lures were put away without drying, the box should be opened to allow drying, thus preventing rusted hooks and damaged lures.

LESSON 12

Tackle Maintenance and Related Activities

LESSON

12

Tackle Maintenance and Related Activities

Lesson Objectives

Following this lesson students will:

1. Understand the necessity of properly maintaining tackle.
2. Be able to perform simple repairs on rods, reels, and lures.
3. Know which tackle can be modified and which types are difficult to change.
4. Know how to prepare a simple tackle repair kit for use in the field.

Materials for the Lesson

1. Old nylon stocking to check for damaged guides.
2. Wet rag for wiping rod.
3. Can of demoisturizing spray.
4. Reel oil and grease.
5. New guide thread for wrapping a guide.
6. Spool of new line, 6 to 10 lb. test.
7. Parts for lure modification—tape, fast drying paint, glitter, hooks, skirts, and metal polish.
8. Tackle repair kit.
9. Reel parts (level wind, bail spring, etc.) if you will plan to repair a reel.
10. A manufacturer's booklet that was included with a reel.
11. An old, fully functioning rod and reel and one of similar age that does not work.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
	If you plan to go into extensive detail for this lesson or if you will have the students performing maintenance and repair activities, it would be advisable to have assistance.If assistance is not readily available, demonstration only is suggested. With younger students, if they can be made aware of the importance of proper maintenance and know how to make minor repairs, you will have been successful. With older students, more emphasis on actual repair and modification techniques will be of great interest.
	1. Introduce class to the lesson objectives.
I. Tackle Maintenance A. Rods B. Reels C. Lures D. Accessories	2. Introduce students to the importance of maintenance by asking them to compare the two old fishing outfits that you brought. After they have seen that one works and the other one won't, indicate that the major difference is the maintenance that the functioning one received. 3. Compare the maintenance of fishing tackle to the importance of maintaining something else of importance to the students such as a bicycle, car, toys, or perhaps tools. 4. Ask the students to indicate why proper maintanence could be important. Lost fish, broken line, and many other reasons can be given. Discuss several simple ways that tackle can be maintained and cared for. Use the old nylon and show them how to check guides for rough spots that can damage line. Using the wet rag, show them how to wipe the rod and reel clean after using. Take reel apart and show students how to wash it as this is especially important after fishing in salt or brackish water. Show them the demoisturizing spray and how to protect the fishing line while it is being used. These are all simple maintenance procedures that can be performed by anyone.
II. Tackle Repair A. Rods B. Reels C. Lures	5. Take the cover off of the reel and show where to use the reel oil and grease. Show the manufacturer's book and the expanded diagram of the reel and show where it states the recommended oil and grease points. Grease and oil the reel with the students observing. 6. Discuss the care of lures and how to organize hard plastic lures in tackle boxes. Also discuss that only soft plastic lures of the same color should be stored together since the colors will "run." They should also be made aware of the need to leave a tackle box open after fishing so that wet lures can dry without rusting.

Lesson Content Outline	Classroom Procedure
	7. Using the line, demonstrate how to check for abrasions by running the line between your fingers. The line is the only connection with the fish and worn line should be cut off or old line replaced. Using one of the tackle outfits, demonstrate how to replace line on the reel.
	8. With more advanced students, demonstrate how to replace a guide by first removing the old guide and then wrapping on a new one. If possible, each student could practice on a rod that they had brought to the class. Also demonstrate the procedure for replacing a broken tip top, by heating the old one for removal and them placing a new one on the rod. Trim wrap can also be added to finish the process. Show students how to use the color preserver and varnish to protect the new wrappings.
	9. Again, with older students, dismantle a reel and demonstrate how to keep the parts in order for reassembly. Egg cartons work very well for this. Replace one or more bad parts on the reel. If students brought a reel and spare parts, assist them while they make minor repairs.
III. Tackle Modification	10. Discuss how lures can be modified by adding skirts, new hooks, spraying a different color, adding glitter, or reflective tape. Demonstrate some of these techniques using the materials you brought and an old lure. Care must be taken that the purpose of the lure is not radically changed with these alterations.
IV. Tackle Repair Field Kits	11. Show your tackle repair kit to the students and suggest that they carry a similar kit or an extra rod and reel while on fishing excursions. Reel tools, oil and grease, cleaning tools, and minor spare parts can save a fishing experience from disaster. If extra tackle is not available to the angler, this item is essential, and certainly not a luxury.
	12. Encourage students to maintain their fishing tackle so that it may serve them well for many years of fishing pleasure. Many books on the subject are available, but most major repairs can be avoided by proper care and maintenance.

INTRODUCTION

Most students are very interested in fishing tackle. This lesson provides the opportunity to help them learn how tackle works and why it must be maintained properly. It also allows an opportunity for the students to bring their own tackle for examination and to discuss future equipment purchases. The condition of their equipment can be evaluated with adjustments and repairs being made for students needing special help.

Rather than being a difficult task, tackle maintenance and repair is easy, fun, enjoyable in the off season, and beneficial by providing smoothly working tackle. While all lures are designed to catch fish, modifications may improve them under certain local conditions or special fishing situations. Modifications are made to meet a need in making a lure better, not just for the sake of change.

This lesson provides a time to work with students on a one-to-one basis. It also allows an opportunity to bring in local talent to discuss these subjects and to show lure modifications that work well locally.

NARRATIVE

General

The care, maintenance and repair of tackle is necessary for long-term use. Rather than being difficult, tackle maintenance and repair is relatively easy. It is also fun, and for most fishermen, is best done during the off season. Proper maintenance involves not only cleaning and checking, but also the proper storage and use of equipment.

Tackle Maintenance

Rods should be used for the tasks for which they are designed, for casting, trolling, and fighting fish. They should not be used as a boat pole, as a lure retriever to push a lure off of a bottom snag, or for other reasons.

Rods must be stored properly on a boat or at home. On a boat, rods should be placed in a rod rack. They should not be allowed (particularly graphite rods) to bang against the boat or to bounce against a boat seat. At home, they should be kept in cases or in a rack designed to store them vertically or horizontally. After each trip, rods should be wiped, especially if used in salt or brackish water. Guides and guide wraps should be periodically checked for damage or wear and replaced. This should also be done at the end of each season.

Reels should be spooled with line appropriate to their size and use. Thus a small reel should be spooled with light line, with heavy line used on larger reels. Set the drag for a reel at the beginning of each trip, and after each trip, back off the drag to preserve the soft drag washers and to keep the drag working properly. If a hook becomes snagged, do not pull the line with the reel since this could cause spool damage.

After each trip, the spool should be removed and the reel washed, especially if used for salt water fishing. Protect the line and spray the reel with a demoisturizing agent for added protection. The reel should be oiled and greased periodically, in accordance with the manufacturers instructions, with attention given to parts emphasized in the reel manual, such as rollers, bail joints, level winds, handles, and shafts. Some reels have oil ports for this purpose.

At the end of the season, the reel should be sent to a reel service center, a good service oriented tackle shop or a service center listed with the literature received with the reel, or dismantled for cleaning. Take the reel apart carefully, following service manual instructions, and keep parts in order for reassembly. Use an egg carton, biscuit tin or other box with small compartments for holding parts for easy reassembly. Carefully check all small parts and order replacements if necessary. Lubricate following the manufacturers instructions and reassemble. Each time that the line is changed, the reel should be carefully cleaned and polished to prevent corrosion and damage.

While fishing, the line should be checked often for abrasions and cut off when abrasion occurs. Line should be replaced frequently or whenever it becomes stiff, kinked, twisted, or otherwise in less than good condition.

Lures are best stored in tackle boxes, but placing too many lures in each compartment will allow hooks to scratch other lures. Also, soft plastic lures such as worms, salamanders, vinyl skirts, rubber and plastic skirts, grubs, lizards and the like must be kept separate from metal and hard plastic lures since the different plastics will react and harm the lures. Soft lures should be separated by color as colors can migrate from one lure to another and cause discoloration.

If lures become wet from fishing, the tackle box should be stored open to dry out its contents. Lures which become damaged or have broken or bent hooks should be removed for repair or replacement. Hooks should always be kept sharp and checked before and during fishing.

Accessories also require care. Nets should be checked for holes, gaffs must be kept sharp and safely stored, and rubber fishing boots should be kept in a cool, dark place, preferably hanging or folded in a plastic bag to prevent ozone damage. Tackle boxes must be periodically emptied, cleaned and dried.

Tackle Repair

Proper care of tackle will prevent many repair problems, but accidents do happen. Some suggestions for simple repairs include the following:

Rods often have guide problems. Guides are held in place with thread wraps which can be cut off and replaced. All guides are wrapped the same way, regardless of rod type. Tip tops must be heated carefully to remove (protect the rod material from heat damage while heating the metal tip top) and can be replaced with a new tip top of the same size. A trim wrap similar to a guide wrap is usually placed at the tip top. After adding any replacement wraps, it is necessary to protect them with color preserver to keep the thread color from changing and a varnish or epoxy rod finish. Only the wrap need be protected this way.

Butt caps can also be removed and replaced. More extensive repairs involving broken rods, ferrule replacement, loose reel seats and damaged handles are best left to tackle service centers.

Reels can develop problems with bail springs, lost nuts and bolts, bad gears, damaged handles, and deformed drag washers. The replacement parts can be ordered from the reel manufacturer. While dismantling a reel, keep all parts in order for reassembly. Remove the damaged part(s) and replace, carefully following the manufacturer's schematic drawings included with the reel. Lubricate the reel during this process.

Lures can be repaired if the damage is slight. Most soft plastics can't be reused as they are, but can be saved to be melted down and molded into new lures, per instructions in Lesson 13. Replace hooks on other lures with new ones of the same style and size, using the same lure hook hanger or a split ring to hold the hook if the hook hanger is molded in and not removable.

Plugs or crankbaits that run off to one side can be adjusted by shaving the lip or slightly bending the line eye (on the opposite side to which they run) to correct any imbalance. Worn paint can be replaced by painting with lure paints now available for hard plugs and jig heads. Spinners and metal spoons can be polished with steel wool and coated with a clear finish for protection.

Other tackle can also be repaired. Tackle box latches and hinges will sometimes break and replacement parts are usually available from the manufacturer. Rubber fishing boots can be repaired using puncture repair kits available at any convenience store or supplied with the boots. Nets with holes can be repaired using net twine, available from craft stores. To reweave the damaged mesh, a special net knot similar to a sheet bend is used.

Tackle Modification

Rods can be modified in several ways. A long spinning rod can be made into a conventional spool flipping rod by removing the large guides and replacing them with casting rod guides. A long rod can be made into a short, stiffer rod by cutting off some of the tip section and replacing the tip top with one of a larger size.

Reels are more difficult to modify and require manufacturers replacement parts to do so, but some simple things are possible. The simplest modification is the choice of the arbor, which is supplied with most casting and some spinning reels today. These allow the use of the full spool for large line capacity or an arbor with less line capacity. Handles can be replaced with those of a longer or shorter shaft. Special attachments make it possible to make older style casting reels more comfortable through the addition of a flexible fitted cap, a slip on thumb bar style casting lever, a screw on line cutter, or other accessories.

Lures can be modified, but care must be taken so that the purpose of the lure is not changed by radically altering the action, color, and hooks. Refinishing lures is easy and involves polishing metal parts and painting metalic and non metalic parts. Thus, a spinner blade could be cleaned to its original finish, sprayed a different metallic finish or painted a new opaque color. Permanent felt tip markers in various colors are also good for slight shading of metallic surfaces. Special paint kits just for lures are also available.

Additions to lures are also possible. Tape can be added to lures and works best on relatively flat surfaces with simple curves. Glitter tape, colored tape, tape-cut outs, reflective tape, and glow-in-the-dark tape are all available. Tails and skirts are additions that can be added to many lures including jigs, plugs, spinners, spinnerbaits, buzzbaits, trolling lures, and spoons. Skirts are usually added to the hooks. Finally hooks are easily changed on most lures. A plug with a treble hook can be modified with a double hook to make it more weedless or a single hook for easier unhooking of toothy fish such as bluefish or pike.

Tackle Repair Field Kit

A tackle repair field kit makes it easy to repair tackle in the field but should not be considered a substitute for regular care and maintenance. Such a field kit is best for long trips or vacations where help might be far away or extra tackle might not be available.

To make such a kit, assemble the following along with a small lure box to store these parts: *Reel tools*—such as are supplied with the reel along with tiny screwdrivers and wrenches for reel cleaning, adjustment, and repair. Also include a small pair of pliers and split ring pliers. *Oil and grease*—for oiling and lubrication of reels. Store in a small bag to prevent leakage. *Cleaning tools*—pipe cleaners, cotton tip swabs and similar items to remove grit and grime from tackle, especially reels. *Spare parts*—a small set of replacement parts included with most reels. Take these along with a spare guide or two, tip tops in several sizes, hooks, and split rings.

LESSON 13

Lure Making and Related Activities

LESSON
13

Lure Making and Related Activities

Lesson Objectives

Following this lesson students will:

1. Know how to make simple lures.
2. Know how flies and floating bugs are made by hand.
3. Know how to wrap a guide and basic rod building techniques.
4. Be able to take good outdoor and fishing photographs.
5. Comprehend taxidermy basics.
6. Understand how fishing can be enjoyed while canoeing, boating, picnicking, camping and backpacking.

Materials for the Lesson

1. Examples of homemade lures and parts for making simple lures.
2. Fly tying materials including a fly tying vice, hackle pliers, materials, hooks, etc.
3. A rod blank, guides, and other parts necessary for building a fishing rod.
4. Examples of good and poor fishing and outdoor photographs.
5. Several mounted fish, if they are available.
6. A taxidermy kit.

TEACHING STRATEGY

Lesson Content Outline

- **I. Related Hobbies**
  - A. Photography
  - B. Taxidermy
  - C. Canoeing
  - D. Camping
  - E. Picnicking
  - F. Backpacking
- **II. Tackle Making**
  - A. Lures
  - B. Fly Tying
  - C. Rod Building
  - D. Rod Racks

Classroom Procedure

A great deal of diverse material is covered in this lesson. You might wish to consider which is the most important to cover or which is of highest interest to the greatest number of students. Other alternatives are to extend the lesson time to cover all aspect of the lesson or to invite local specialists to cover certain topics and the class into interest groups for several extended class periods.

This lesson plan assumes that you will only introduce the topics during the planned class time. If enough students are interested in one or more of the subjects, experts in the subject area (s) can be called upon to teach an extended class.

1. Introduce students to the lesson objectives.
2. Discuss areas that have become hobbies for many outdoor, fishing enthusiasts. Include photography, taxidermy, fly tying, rod building, and lure making in this discussion.
3. Discuss how fishing can be enjoyed as part of other outdoor activities including picnicking, camping and backpacking. Ask students to relate personal experiences during this discussion.
4. Discuss lure making, fly tying, rod making, taxidermy, and photography in detail. Show examples and allow students to participate in selected simple experiences in each area. Much can be done by demonstration. (They will not become accomplished in any area during the class. However, their interest may be expanded to the point that they would participate in an additional class.)
5. Have students relate personal experiences with camping, canoeing, backpacking, and picknicing when they have also enjoyed fishing. Discuss the types of tackle used and why, what was caught, and how the catch was utilized.
6. Ask students if they would like advanced lessons in any of the special areas covered by this lesson. If there is an adequate number in any area, tell them that you will locate an instructor and arrange a time for them to begin.

INTRODUCTION

This lesson should promote a high degree of interest among most students since it is a "hands-on" lesson involving fishing-related hobbies. Since craft tools and materials are involved, one MUST instruct students in the safe handling of such tools and materials. In this regard, instructors that are completely familiar with the topics are important for the success of this lesson.

NARRATIVE

General

Lure making, rod building, and fly tying are all excellent high interest, fishing-related hobbies. They expand the interest, knowledge and understanding of fishing, while providing hobbies that can be carried out in the off-season and throughout life. In addition, related interests such as outdoor photography, taxidermy, canoeing, picnicking, camping and backpacking also can have a direct tie with fishing.

The related interests of canoeing, camping, and backpacking, allow fishing to be expanded to other family members who might be too young or lack the interest of serious anglers. The hobbies of lure making, rod building and fly tying also have definite advantages. These include reducing the expenditure for tackle (although serious hobbiests often spend a great deal), allowing the making of tackle that is not available commercially, and providing fun when fishing is not possible.

Lures

Making lures is a direct, high interest way to relate to fishing. Lures can be made and immediately used to catch fish. The parts and tools necessary to make any type of lure are available from tackle shops and mail order houses. Different types of lures require different skills. Spinners are among the easiest to make since they require no finishing or art/craft skills, but are merely assembled from the various parts such as shafts, blades, bodies and beads, and hooks. The parts are assembled by placing each part on the shaft in order, adding the hook and bending an eye with a small pair of pliers. Soft plastics can be molded easily on the kitchen stove, using a low heat to melt the plastic and prepared molds to form the soft plastic lure. Worms, grubs, and salamanders are commonly made. To make these soft plastics, liquid plastic is melted in a pan, color added (old soft lures of the same color can also be added at this point), and the resulting liquid plastic poured carefully into a mold and allowed to cool. Molds can be constantly rotated as the soft plastic lures are removed from the mold. Use care in handling molds and plastics since students will be working with materials on a stove at a temperature of approximately 375 degrees.

Plugs can be made in several ways. Plug bodies can be purchased and hooks added with split rings to make finished lures. Some plug bodies require painting; others come finished.

To make plugs from scratch, begin with a small block (1 1/2 × 1 1/2 × 6 inches is good) of basswood or white cedar. Make a template of the shape of the plug to be carved and trace that outline on the block. Some may need a different template for the sides and back of the lure, depending upon its shape. For a cigar shaped plug, one template can be used for all four sides of the block. Draw the template lines on the block and carve away the wood. After carving, rasp the wood into shape and finish with successively finer grades of sandpaper. Add hook hangers and line eyes and paint the lure. Once the paint (several coats or one coat) is dry, add the hooks using hook hangers, screw eyes or split rings.

Jigs can be molded or purchased already molded on hooks. The best way to start is to buy premolded heads and use fly tying techniques to tie on the tail material. An exception would be those jigs designed to hold a soft plastic tail, not a fur or feather tied on tail. Tie the tail on by wrapping thread around the collar of the head and around the tail materials. Then finish wrapping the tail, tie off and paint the head and wrapped area by dipping. Hang up to dry. Extreme care must be used in molding jigs with two part molds since the lead must be heated to approximately 600 degrees for pouring.

To do this, heat the lead, preheat the mold (so that the cavities in the mold fill properly), add the hooks and pour the lead through the sprue hole. Allow to cool and carefully remove the molded heads. Follow as above to finish. When working with a group, absolute discipline must be maintained and everyone must adhere to good working methods to insure proper safety.

To make spoons, the spoon blades can be purchased, but old stainless tea and table spoons can be used by cutting off the handle and drilling holes for the line and hook. In either case, finish the spoon as desired (paint, metalic spray or clear finish) and add the hooks with split rings. Add a split ring as the line tie to prevent the line from being cut on drilled or rough holes.

Fly Tying

Most experts agree that one of the reasons for the high interest in fly fishing is due to the fact that many anglers tie their own flies. Fly tying requires some tools such as a fly tying vice, hackle pliers, and a thread bobbin, although one can start without these. A pair of locking pliers or two large washers clamped in a workshop vice to hold a hook will suffice.

The basics of fly tying are simple. They involve wrapping materials around a hook shank with thread. Begin by clamping the hook securely and wrap the thread around the hook shank, crossing over previous wraps to secure the thread. Once this is done, materials can be tied to the hook shank and wrapped in place. A standard procedure for a simple fly is to tie the thread behind the eye of the hook, then tie a body material of wool or chenille. The body material is wrapped along the hook shank and back, where it is tied with the thread. The excess body material is cut, a wing of feathers or fur tied with the thread, the excess cut, and the head completely wrapped and tied with half hitches. Naturally, variations of flies and tying techniques can be used in addition to this basic method.

Variations in simple streamer flies (as above) can be made by varying the above tying instructions. Dry flies are designed to float, so use light, water resistant materials along with stiff tail fibers and a stiff collar of hackle to make the fly ride high in the water. Wet flies and nymphs are just the opposite, using soft webby materials for a life-like appearance underwater. Streamer flies are tied on long shank hooks, using long wings to imitate long insects and minnows.

Bass bugs, similar panfish, and salt water bugs are made on hard foam or cork bodies designed to float high in the water. Tails are tied on, but the main body is cork or foam. Hard-to-tie hair-bodied bugs are also tied, packing quantities of hollow deer hair on a hook shank, which is then trimmed to size.

Rod Building

Rod building is relatively easy and involves nothing more than assembling the handle parts and wrapping the guides in place. Tools for rod building are available, but are not needed for the beginner. For example, a simple way to wrap guides includes placing a spool of thread in a tea cup and running the thread through a phone book (between two sheets of writing paper to keep it clean) to maintain the tension needed.

The parts necessary to build a rod include the rod blank, guides, handle reel seat, butt cap, tip top, thread, glue, and finish. Begin by gluing the handle parts (cork rings, preformed grips or synthetic grips) onto the rod blank. Glue the reel seat in place, shimming the space between the rod and the reel seat, and add the foregrip. Once the glue is dry, wrap the guides in place. File the guide feet to make for a smooth transition of the thread on the guide, and tape the guides in place. Begin the wrap on the blank by crossing over the thread as the blank is rotated and wrap the threads tightly against each other. Wrap up over the guide foot, wrap over a loop of thread, and continue to the end of the guide foot. Cut the thread, tuck into the loop and pull the loop to secure the thread. Cut the excess and repeat on each guide foot.

Variations of the above include the type and positioning of the reel seat and handle parts and the type of guide wrapped in place. Heavy rods require heavier thread and a double wrap.

Related Hobbies—Photography

Pictures help to remember good fishing trips, companions, fish caught, fun on-the-water, and vacations. Good photos require an understanding of photographic composition, regardless of the camera used.

Most cameras today automatically set the proper exposure. A good picture involves the effective use of lighting and composition. Use front lighting (light falling on the subject from in back of the photographer) for simple photos such as record catches or photographs of friends. Use side lighting or back lighting for dramatic photos of scenery, dawn or dusk photos, and other simple subjects.

Composition involves the placement of elements in the photo. The most common error is to take a photograph too far away, so that not only the subject, but much surrounding area is included. In any photograph, examine the subject as well as the surrounding area. Be sure that the subject fills the frame. Also, guard against distracting backgrounds that will conflict with the subject.

Placement of the subject is also important. Subjects such as boats, fishermen, and hikers should face into the photo rather than out of the photo to sustain viewer interest. To obtain good fishing pictures, take a variety of shots from different angles, distances and of different subjects. Include scenics, detail shots of tackle, views of friends fishing and with fish, and pictures of fish being landed.

Taxidermy

Taxidermy involves preserving fish and other creatures so that they can be remembered and also serve as a "trophy." Taxidermy kits and courses are available, and any taxidermy method takes time to accomplish. Unlike rod building, fly tying, and lure making, in which the results can be seen immediately or in a few days, taxidermy usually takes weeks of careful work.

Fish stuffed by skinning and perserving seldom last long. A better method is to make a two-part mold of the fish, laying the fish on a fine sand base, making sure that the sand border follows the centerline of the fish exactly. Pour smooth plaster of Paris into the mold, and allow to cure overnight. Turn the fish over, remove all the sand, add vaseline to the mold parts and pour a second layer of plaster. Allow to cure, remove the fish, cut an opening or sprue hole on the back side and fill the mold with epoxy or liquid boat-builders resin. Allow to harden, remove, and add a glass eye and paint after covering with a filler primer or base coat. Use book illustrations for proper paint patterns.

Taxidermy done this way requires some skill but can be accomplished. It does take time, so students with a high degree of interest should be encouraged to try it and report their progress weekly until their fish is complete.

Related Outdoor Activities

Many activities can be enjoyed with fishing. Canoeing, boating, picnicking, camping and backpacking are just some of them. Boating and canoeing are naturals, even if the main purpose of the trip is not to fish. Enough of the appropriate fishing tackle must be taken along in either case so fishing can be enjoyed during a break or lull. When boating, store all tackle so as not to damage the equipment when it is not being used.

When canoeing, carry only minimal tackle since canoes are limited in available space. This becomes even more critical if on a canoeing/camping trip, but even then, minimal lightweight tackle can be carried along.

Picnicking allows a family and large groups to gather. When picnicking near water, there is no reason why tackle cannot be carried along for fishing. Trips like this can also be used to present fishing to those lacking an interest in the sport.

Camping and backpacking are both ideal when fishing is an adjunct. When camping, be it by tent, trailer, RV or motor home, tackle is easily carried for each family member. Backpackers are often reluctant to take fishing tackle since weight is a problem. The solution is to carry only one light rod (pack type spinning or fly rod) strapped to the frame of the backpack, with a reel and small box of flies or lures in an outside pocket. This way, the tackle can be used at each evening stop, as well as for breaks.

LESSON 14

Locating Fish

LESSON
14

Locating Fish

Lesson Objectives

Following this lesson students will:

1. Understand the necessity of evaluating "reading" different types of water to locate fish.
2. Recognize the value of simple maps and charts and their use with a compass.
3. Be aware of visual sightings and the methods involved for relocating good fishing spots.
4. Know what types of fish are most likely to be found in specific types of structure.
5. Recognize types of structure in fresh and salf water and their importance in finding fish.
6. Recognize the importance of using temperature, oxygen, shade, pH, and water clarity in locating fish.
7. Understand that electronic fishing aids are useful in finding fish.

Materials for the Lesson

1. A map or a chart of a locally popular fishing lake. One showing contour lines, if possible.
2. Photocopies and overhead transparencies of the graphics from the appendix.
3. An electronic flasher unit or other type of electronic aid for locating fish.
4. Paper run through an electronic graph unit on a fishing boat.
5. If possible, see if a local fisherman with a fully equipped bass rig will bring it to the class and discuss the use of the electronic equipment.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	1. Introduce students to the lesson objectives.
II. Reading Water A. Still Water B. Running Water C. Saltwater-Inshore	2. Conduct a discussion with the students about the importance of being able to eliminate water *not to fish*. They want to fish where the fish have a good chance of being. These locations will vary with the species sought, and also on available food, oxygen, temperature, pH, light, structure, and schooling tendencies. Learning to understand the special needs and preferences of a species is critical to angling success. Experience is perhaps the best teacher, but even without the use of electronic aids, there are some things that every angler can do to increase his/her chance of success. 3. Ask the students to suggest ways that they can see to determine a good place to fish on a body of water that they haven't been to before. Answers can include looking at the bank steepness, type of soil or rocks, trees sticking up out of the water, lilly pads or other aquatic vegetation, boat docks, points,etc. are possible answers. These all refer to some type of structure. At nearly any time of year, many species of fish will be attracted by structure of some type. Hence, fishing those spots that are visible is a good idea.
III. Charts and Maps A. Using Maps B. Using Charts C. Using a Compass	4. Utilize transparencies of the maps showing a lake during different seasons of the year. Distribute photocopies to the students. Select one and ask the students to tell where the fish are. In all of the photos, the fish are near some type of structure. Some of it not visible without a map or a piece of electronic equipment. However, exlain to the students that there would be several obvious places for them to fish without any additional assistance other than what they could see. Ask them to name them or point them out on the screen.
IV. Structure A. Fresh Water B. Salt Water	5. Utilize the maps or charts of a locally popular lake with the students. Explain the contour lines and that when they are close together, the bottom drops away rapidly. Utilize the map or chart and have the students suggest places to begin fishing on their next trip there. Suggest others if they miss some obvious places. 6. With the same map or chart, show the students how to use a compass to find those places. Start from the boat dock, aligning the map to magnetic north as indicated on the compass. Have the students tell you how they would go to get to the good fishing spots that they have identified.

Lesson Content Outline	Classroom Procedure
V. Electronic Fishing Aids A. Flashers B. Graph Recorders C. LCD Depth Finders D. Color Meters E. Oxygen Meters F. pH Meters G. Temperature Meters	7. Inform the students that many advanced anglers use several electronic aids to help them locate fish. Use transparencies from the graphics section to briefly explain these. If you were able to have a fisherman come with his boat, have him/her explain how he uses these items. Have him explain the recordings made by his/her graph recorder, pointing out fish and underwater structure not visible to the human eye. Have the angler explain how he uses pH, temperature, oxygen, and structure to locate locally popular fish. If you are near the ocean or large bodies of water, it would be worthwhile to discuss the use of loran C to relocate a specific fishing area. Tell the students that they will have time to look at the boat and its instruments in a few minutes.
VI. Sightings A. Methods B. Triangulation C. Visual	8. Explain to the students, that on smaller bodies of water where shore can be seen, it is possible to return to a good fishing location by using triangulation. Use the transparency and photocopies of the graphics to explain this concept. Basically it involves lining up two landmarks in different locations, as much as possible at right angles to each other. That makes it possible to follow out on a line from one marker until you reach a point that intersects a line from the other point that you have reference to. Drop your anchor and begin fishing. 9. Discuss the fact that it is possible to become a more successful angler by eliminating much water by visually selecting places to fish or by using maps and charts.

INTRODUCTION

This lesson is designed to acquaint students with the fact that fish are not uniformly distributed through any water system, be it pond, lake, river, stream, or ocean. If fact, much of these areas are devoid of fish most of the time. Knowledge of aquatic communities and of fishing depends on understanding that habitat will vary with the fish species, feeding habits, temperature range, and oxygen tolerances.

NARRATIVE

General

Fish are not randomly scattered through any body of water, be it a pond, lake, large reservoir, stream, river, ocean, bay or slough. Fish are always found in specific areas. These areas will vary with the species of fish and the environment in which they live, but are based on typical factors that involve every living thing—food, oxygen levels, temperature, pH, light levels, structure and schooling tendencies. While all fish will be affected by the availability of food, oxygen, and temperature range, some species vary as to their need for structure, schooling tendencies, pH, and light levels.

Learning to understand the special needs and preferences of a species is critical to locating fish in any body of water. Thus, the biology of a given species determines just where and how it will live. Facts learned about each game species indicates where to look for it. Examples would be the salmon/trout species, which inhabit rivers or follow oxygen and temperature levels in lakes; bass, which will relate to structure near food and migration paths; and carp, which usually do not relate to structure but forage or graze on the bottom. There are fine differences between related species, such as the largemouth bass preference for wood as structure, while smallmouth bass prefer gravel, rock or stone rip rap.

Reading Water

Much can be learned by carefully recognizing how to decipher what is underneath the water's surface. Often fishermen call this "reading the water." It simply means utilizing knowledge and experience to best determine structure and currents and where a given species might locate in relation to these currents, depths and structure types. This helps the fishermen to know when, where and how to present a bait or lure to these spots in hopes of hooking a fish.

Still water is the most difficult to interpret since the calm surface gives no indication as to the bottom depth or any other features that might be found. Often the best way to read a lake, pond or reservoir is to examine the surrounding landscape. Barring man-made changes, the steepness of the shoreline, type of bottom (rock, soil, etc.) will be the same as found above water in the same area. Water plants such as lily pads and shoreline plants such as cattails often indicate shallow areas of water, while man made lakes and ponds will often have their deepest part located where a dam is constructed.

Running water is far easier to read. Current gives indications of the water depth and any underwater structures. Underwater rocks and boulders make surface swirls. The size of these swirls is relative to the size of the rock and also its depth under water. Rocks and boulders are also important to note since each rock or obstruction (island, bridge, piling, dock, pier, or buoy) will make a cushion of water around it that allows fish to rest in comfort, yet still be close to any food that might move by. Thus, these are ideal places to fish for smallmouth bass, trout, sunfish, catfish, and walleye.

These buffers, or comfort zones, are also important in salt water fishing for the same reason. Species such as sea trout, striped bass, snappers, sea bass, cobia, perch and similar fish will locate around these areas. Both inshore currents and bay and estuary tidal flows will cause the same strong currents that run in rivers. These tidal currents will vary with the force of the tide since the tide will reverse itself daily. Often the best places to fish around obstructions or currents is on the down current side where fish can lie in protected water, yet easily reach food that is sweeping by. The down current side of any obstruction or structure will reverse each time the tide changes.

Charts and Maps

In addition to becoming experienced in reading water, maps and charts are also helpful. Maps and charts are different. Maps, by definition, are drawings of a land area that often includes rivers, lakes and ponds. Some of the most useful maps show the area of a man-made lake before the lake was built. Thus, the contours shown, roads, creeks, old building foundations, and railroad beds, are all indicated and when superimposed on a new map showing the lake (which will usually only show the water surface), can become a valued fishing aid. Map makers and publishers are beginning to realize this and many maps show bottom depth (numbers or contour lines), bottom structure, bottom type, fishing spots, and man-made objects which attract fish.

Charts which are specifically of the water area only show superficial features of the adjoining land. Charts are usually made only of large bodies of water and are available for all of the salt water coastline and the Great

Lakes. These indicate bottom depth, structure, reefs (natural or man made), courses (compass readings to run from ports to fishing spots), channels, and piers.

To use a map or chart, the angler must orient it properly by using a compass to line up the magnetic north as shown on the compass with the north as indicated on the chart or map. (Corrections for the difference between true north and magnetic north are indicated.) By doing this, one can obtain directions to fishing areas from the dock or launch ramp and can follow these courses with the compass using a reckoning as to time and distance to arrive at the fishing area. Maps or charts are very useful in locating potential fishing areas prior to fishing.

In using maps and charts, it is important to correlate the information of the species being sought. For largemouth bass, find shallow areas, stump fields, standing timber, underwater structure, hummocks and humps, weedy shoreline areas, breaklines (a sharp difference between one level and a sharp drop off), creek beds and similar areas. For walleyes, locate deep rocky areas, often near running water, such as creek mouths. For coastal salt water species, look for comfort zones where fish can hide, such as pilings, bridge abutments, docks, shoals, bars, buoys, and reefs, or follow fathom lines for free swimming ocean species. For the migrating fish such as bluefish, fish the open water areas while trying to locate the bait on which these fish feed.

Structure

Structure is nothing more than something unusual on the bottom or in the water around which fish gather. Normally, it has to be unusual or atypical structure or noticeable structure to be a good fishing area. In a whole shoreline littered with stumps, largemouth bass could be likely found but would not be attracted to one stump as opposed to any others. A barren shoreline with a small area of several stumps would tend to concentrate largemouth and make for an excellent fishing structure.

The same would apply to rivers where one large boulder might concentrate a number of fish. A pool lined with a number of rocks could hold fish, but without the tremendous fish attraction of the single boulder. Similarly, a patch of rocks or gravel on the soil bottom of a lake can create structure for walleye or smallmouth bass. On a lake with a mixed rocky and mud bottom, carp or catfish are more likely found over the mud since these fish relate to the forage found in soil or sand. It is important to know not only the structure, but also the structure desired or preferred by the target species.

In salt water, structure can be anything that will attract fish—oyster bars, shoals, pilings, docks, piers, bridge abutments, buoys, old wrecks, and reefs. Ocean fish such as dolphin are attracted to floating structure, offering an opportunity for ocean trolling anglers to troll past any spotted flotsam.

Electronic Fishing Aids

A number of electronic fishing aids are available to help anglers find fish. Some are simple and inexpensive, while others are very expensive and necessary only for fishing from large fishing boats.

Depth finders are sonars which read the bottom and show what is down there. These began as "flashers" with a small light rapidly rotating around a dial indicating the water depth. With experience, it is possible to determine the type of bottom and also the presence of brush or other structures.

Chart recorders are similar except they record on paper the depth, including structure, brush, fish and the bottom for a permanent record and easier interpretation. Many are extremely sophisticated with computer chip technology and thousands of range possibilities. With advanced models, objects 1 1/2 inches apart can be seen as separate objects on the screen.

Newer technology in depth finders includes those with a liquid crystal display (LCD) screen (similar to the screen on many digital watches) that has a picture similar to the chart recorder. The picture constantly changes and is not retained as is a chart picture. The picture is shown in small black blocks or pixels. Some models do have a memory to "hold" pictures for later review and analysis.

Color meters (really light meters) measure the amount of light and visibility of certain colors. This helps the fisherman choose a lure with the most visible colors in different types of waters and at different depths, presumably so that more fish will see and strike it. Several different brands are available, and all work on the general principle of a photographer's light meter. Charts to indicate the best color lure are included with these. Many lure companies now make lures in these special colors.

Oxygen meters also are helpful in determining the oxygen levels of water. Oxygen requirements of different species vary, with some species such as trout and salmon requiring much higher levels of dissolved oxygen than species such as catfish. The meters help to find these levels and also indicate areas in a lake, pond or river where low oxygen might preclude any significant fish populations.

pH is measured on a scale of 0–14. pH meters measure pH in water and help determine if the best range of pH is available for fishing. Best fishing is usually found close to the neutral range of 7.0. Water that is too acid (less than 7.0) or too alkaline (more than 7.0) is detrimental to fishing and the chance of success.

Temperature meters measure the temperature of the water. Surface temperature meters are built into some boats, but some include a small thermocouple on the end of a wire to allow recording of temperatures at various depths. The importance of measuring water temperature is to determine seasonal migrations of fish such as bass, or to locate water at a temperature preferred by free swimming fish such as lake trout and salmon.

One of the most sophisticated instruments is loran (or loran C), which provides a reference point on the water to be registered as a series of coordinate numbers for future reference. To return to the same spot, these numbers can be stored in the loran. Later the loran can designate a course to reach the same location and indicate when it is reached. Some are coupled with the boat steering mechanism so that specific locations can be found automatically.

Sightings

The use of available information in terms of visual sightings, depth soundings, triangulation, and time/distance charts can assist anglers in returning to good fishing locations without the use of expensive electronics.

The simplest way to mark a location is to take sightings of two landmarks in two seperate locations. For best results, these lines should be as close to right angles as possible. As an example, two pine trees on shore in line with the spot and two telegraph poles at right angles in line with the same spot will give accurate sightings. Then it is possible to follow one line of markers, the pine trees, for example, until the line made by the second two markers, the two telegraph poles, is intersected. This is sometimes called triangulation since the lines form the two legs of a triangle.

Depth soundings, through a measured weighted line, much like old-time sailors used, can be a substitute for a depth finder if the bottom being sought varies, such as over a hump or in a creek channel.

With a compass, readings can be taken of a fishing location and a timed course can be run to reach the spot, based on previous information. It is important to run these courses at the same boat speed each time under the same water conditions, or to make adjustments for any differences.

In some cases, sightings can indicate fish. Diving birds indicate the presence of baitfish which are being eaten by predator fish. Lines of debris on the surface often indicates current or tide lines. Some fish will actively feed on the surface and can be spotted by the white water and jumping fish.

Using Total Information to Find Fish

All information concerning structure, oxygen, pH, temperature, food, comfort, and protection from current and migration paths must be considered in finding fish. A beautiful piece of structure with a good temperature is no good if the area is devoid of oxygen. Plenty of oxygen around some structure with plenty of available food may not be good if the temperature is too high for the species sought. Most areas include the necessary physical characteristics for good fishing, but constant monitoring is necessary for consistent success.

LESSON 15

Presentation Techniques and Special Tackle

LESSON
15

Presentation Techniques and Special Tackle

Lesson Objectives

Following this lesson students will:

1. Know how to present a lure, fly or bait to fish.
2. Know how to fish in many types of water.
3. Know why and how to vary lure retrieval.
4. Understand trolling techniques.
5. Be aware of the role of line planers, side planers, downriggers, outriggers, and trolling sinkers.

Materials for the Lesson

1. Photocopies and overhead transparencies prepared from the graphics in the appendix.
2. Examples of trolling aids such as trolling sinkers, dodgers, planers, etc., if used in your area.

Much of this lesson, if not all of it, could be taught at a swimming pool and accomplished by demonstration. A regular classroom can be utilized with the graphic aids, but the use of a pool would allow the students not only to visualize different presentations and see how lures react to different retrieves but also to practice different techniques.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	1. Introduce class to the lesson objectives.
II. Presentation A. Natural Bait B. Lures	2. Discuss why proper presentation of a lure or bait is necessary in enticing a fish to strike. Fish strike baits that look and act natural or those that appear to be injured. Therefore, the presentation of a bait or lure in a natural way can increase success. Also, retrieving a lure in a way that makes it appear impaired, can also entice fish to strike.
III. Retrieves A. Bait B. Lures	3. Ask students for suggestions on how to present bait. Beginning students may have few suggestions, but "correct" answers could include: 1) attempting to cast so the bait lands softly in the water, not with a big splash, 2) using a float to suspend bait so that it appears to be floating, 3) in moving water, casting upcurrent and allowing the bait to flow with the water, 4) using a light weight so the fish can't "feel" any unnatural movement or weight, 5) moving bait slowly, not rapidly, 6) hooking minnows so that they can still swim. Other ideas are in the text material.
	4. Artificial lures must also encourage the fish to strike. Many have a built-in action when they are retrieved, but others don't. Ask students for examples of both types and list them on the chalkboard. Those that have built-in action could include: any type of crankbait, spoons, spinnerbaits, buzzbaits, etc. Those that don't have action of their own, where the angler must manipulate them are: jigs, plastic worms, some top water lures, flies, and fly rod bugs. If you are utilizing a pool, demonstrate the differences. Let students practice with the different types of lures.
	5. Stress that to be most effective that they must understand the fish and its ability to catch and strike a lure. If they are not sure, encourage them to fish the lure slower, rather that faster. Some fish swim very rapidly, while others don't and if the water temperature is cold, most fish move more slowly. Also, if fishing in current, the current may provide all the action necessary.
	6. With a diving crankbait, demonstrate that a lure will swim more deeply if the rod tip is held lower to the water. This can help if the fish are deeper than the lure normally runs. However, with spinnerbaits and buzzbaits, it may be necessary to hold the rod tip up to keep the lure on or near the surface of the water.

Lesson Content Outline	**Classroom Procedure**
	7. Demonstrate methods of varying the retrieve of a lure. Stop and go cranking, moving the rod from side to side, and lifting it up and down slightly. Suggest that they experiment. What works one day, may not work another.
IV. Trolling A. Basic B. Specialized and Advanced C. Trolling Aids	8. Ask the students if they have ever trolled. Ask them what trolling is. In its simplist form, it is nothing more than trailing a lure behind a moving boat. One big advantage to trolling is that several anglers, using lures that travel at different depths can locate fish rapidly. Trolling a new lake permits the angler to cover a wide area of the lake in a short time. Many anglers troll until they locate fish and then utilize casting and/or still fishing to continue fishing in the same general area. 9. Trolling is utilized by anglers in many parts of the country, both for salt and fresh water fishing. For young or inexperienced students you may not wish to continue beyond #8 except to explain that there are many aids available for trolling. These aids include downriggers, outriggers, wire and lead core line, heavy sinkers, flashers, planers, and side planers, and teasers. Each of these aids has a specific purpose in assisting the angler in catching fish. All are used to present the lure or bait to the fish in a way and in a location that will encourage it to strike. With advanced or older anglers the special techniques for the use of these aids can be discussed at length for both salt and fresh water.

INTRODUCTION

Proper presentation of a lure or bait is necessary to be a successful fisherman. To make a proper presentation, the fisherman must make a careful approach and select a bait or lure appropriate for the fish and conditions. The lure must appear natural, and there must be no appreciable resistance to the water (called drag and caused by the line attachment) to alarm the fish.

Baits and lures are presented differently with special retrieves to make them attractive to the fish. A correct retrieve can make an appreciable difference in the speed, depth, action and attractiveness of the lure to the fish.

Trolling is an important, yet often underrated and poorly understood method of fishing. Trolling involves trailing a lure or bait behind a boat so that the bait or lure is constantly moving in new water. It is an excellent way to quickly explore an area to locate concentrations of fish.

Trolling can be a highly sophisticated skill involving a number of fishing aids, such as teasers, side planers, downriggers, outriggers, motor plates, kites and similar gear. All of these aid in getting the lure or bait to the fish.

Trolling speeds and patterns are often overlooked, yet are an important facet of trolling. Trolling speed must be matched to the fish species and fishing area, while trolling patterns make it possible to systematically work an area without gaps or overlapping.

Narrative

Presentation

Both baits and lures must be presented naturally to prevent the fish from becoming suspicious or being scared away. Naturally, it is important to know where fish are. Appproach must be considered a part of presentation since a poor approach will scare fish even before a lure or bait is offered.

When fishing from a boat, it is important to approach likely areas stealthily so as not to scare the fish. This means eliminating loud noises, such as dropping an oar, scraping a tackle box along the hull, or stamping feet. Such noises are easily transmitted through the boat hull. Loud talking or noise transmitted through the air seem to have little effect on fish, despite the admonishment of some anglers to whisper while fishing.

Similarly, a boat engine should be stopped and the boat allowed to drift into place or moved into place with a quiet electric motor, paddle, oar or boat pole. Consideration of currents, tides or winds may allow the boat to drift into fishing spots.

When fishing from shore (see Lesson VII), use similar caution and walk softly along the banks to diminish noisy vibrations in the water. Also avoid bright clothing that might be spotted by close-in fish.

Fish are attracted to baits, but proper presentation is still necessary. A bait must be cast delicately so as not to throw the bait off the hook. In still water, this often means casting beyond the spot where the angler suspects the fish, allowing the bait to sink, then slowly reeling the bait to that spot or until a bite or nibble occurs.

When fishing current, tidal or running water, upcurrent or uptide, cast so that the bait will wash into the area where fish are suspected. The deeper the water and the faster the current, the further upstream or upcurrent the bait must land to drift deeply and naturally.

Baits are best fished with the least possible weight so that they will appear natural and present no danger to the fish. While a snug line is a must to feel the bait, a tight line may signal something unnatural. For this reason, many bait anglers use a "fish finder" rig, in which a sinker holds the bait on the bottom through a sliding ring on the line, yet the bait can be taken freely by the fish, the line sliding through the sinker.

In running water, drift baits are often fished without sinkers so that the bait floats naturally. Often a highly held rod helps keep the line from creating an unnatural drag and also allows the angler to feel any pick up or bite. For this reason, many lure and bait anglers cast up-current, reeling in just enough line to keep contact with the bait, but not enough to cause the lure or bait to drift unnaturally.

Lure presentation is as important as bait presentation since fish cannot usually smell or taste a lure. Lures are usually moved, either by trolling, retrieving, or drifting the lure in a current. Careful casting to place the lure in the right spot is an important part of the presentation.

Fish are almost always startled by anything that lands closely behind them or falls too close. One general rule is to cast far beyond or in front of a fish so that the lure will intersect the movement or location of the fish. This can be accomplished in still water by accurate casting and in fast current by casting up current of the fish and allowing the lure or bait to drift. If the fish is not moving, casting to one side or forward of the fish, then slowly and carefully bringing the lure or bait past the fish, may cause a strike.

Fish will approach a bait or lure because they are hungry or by instinct, which many feel is the reason for strikes of flies by shad, salmon, and similar fish on long spawning runs.

Retrieves

Bait Retrieves

Retrieves of bait are almost always far more passive than retrieves of lures. First, bait is natural food and the fish does not have to strike it immediately, but can take time to investigate, smell and taste it without becoming unduly suspicious. Second, any rapid movement of a bait will usually make it seem unnatural.

Exceptions include trolling surface baits consisting of minnows, large baitfish, strips of bait that look like baitfish, or other swimming creatures such as squid. In this case, the movement of the bait by the slow moving boat is enough to make the strip bait appear live and normal. For fresh water trolling, baits are usually trolled deep or at least under the surface. But again, the purpose is to make the bait appear live and attractive to any game fish and to expose the bait to the maximum fishing area.

Another exception is casting baitfish, strips of bait, and other lures that are also designed to look like moving fish. Worms, bloodworms, clams, insects, crayfish, conchs, dough balls, corn,cut bait, and catfish blood baits must be fished slowly or allowed to drift without any movement imparted by the angler.

Some exceptions occur with the combination of bait and lures, such as a minnow added to a jig or a belly strip added to a spoon, but these are still lures with the bait as an added attraction. A variation of this might be with a heavy unpainted jig head holding a bally hoo, minnow, leech or similar live bait and the lead head being the vehicle to get the bait down to the fish. In this case, the lure is secondary since the fish are going to be attracted to the bait.

The key to bait retrieves then, is to allow them to move or to drift naturally so they appear to be alive and an easy meal. A secret is to modify or injure the bait slightly so that it will react in an erratic fashion, thus attracting fish. Since fish are attracted to injured bait as an easy prey, such modifications make the bait stand out from other potential meals. This includes unusual retrieves that give the bait an erratic action or clipping a fin from the bait to make it swim in circles and appear injured.

When fishing a jig, lip hook a minnow upside down. The minnow will have to try constantly to right itself. This continuing activity helps attract predators.

Lure Retrieves

Lures, as artificial attractors of fish, must be manipulated to entice fish and to provoke strikes.

Many lures have a built-in action. These include crankbaits, weedless spoons, structure spoons, sonic lures, spinnerbaits, buzzbaits, spinners, and in-line spinnerbaits. Lures that do not have built-in action, when action must be imparted by the angler, include jigs and bucktails, some structure spoons, plastic worms, other soft plastic lures, some top water lures, flies, and fly rod bugs.

In all cases, the degree of action varies. Some top water plugs are cigar shaped and, if retrieved evenly, come through the water with no more action than a stick. Others have propeller blades, which create action through the spinning of the propellers, or various lips and plates that cause the surface lure to wobble and dance on the water.

Spinnerbaits, spinners and buzzbaits have no built-in action except the movement of the propellers; sonic lures have a tight, fast vibrating wiggle; crankbaits have a built-in, undulating action, and spoons have a wobbling back and forth action. Lures such as jigs, soft plastic worms, other soft plastic lures and some structure (vertically fished) spoons have no action at all, except for that given them by the angler.

Expert anglers and all lure manufacturers agree, however, that erratic retrieves and movement of a lure—including those with built-in action—will do much to increase strikes and catches.

Even without working a lure erratically, there is much that can be done to make a retrieve effective. First is an understanding of the fish and its ability to strike a lure. Largemouth bass, for example, can turn rapidly to catch a widely ranging, wildly erratic lure. Pike, which can not make quick side moves, require the use of a less wide-ranging lure and a straighter tracking retrieve.

Second, it is necessary to retrieve at the right speed. This is controlled by the fish species, the water temperature and the water conditions. A fish in cold water has a slower metabolism and thus requires a slower retrieve than a fish in warmer water. The cold water also necessitates slower wobbling, less erratic lure action so that the lure can be easily caught by sluggish fish.

Some fish are also faster than others. It is impossible to keep a lure from a barracuda if it really wants it, while a lure for walleye is generally retrieved slowly because the fish do not move fast.

Water conditions can also affect retrieve speed. When fishing in running water with a cross stream cast, no retrieve is required initially since the lure moves rapidly as a result of the water current and line drag. The lure is moving and attracting fish, but it is not being retrieved by the angler.

Rod angle also greatly affects another aspect of the retrieve, the depth at which a lure runs. Crankbaits, designed to run deep, will not run as deep with the rod held at a high angle as when the rod is held with the tip down or touching the water. Some anglers go to the extreme of using long, (usually seven feet), stiff rods held straight down in the water to gain extra depth.

Depth of a lure is also affected by line size. Everything being equal, a lighter line will have less water resistance and run deeper than a heavier line. This applies to casting, drifting and trolling.

This does not necessarily mean that a low rod angle is always good, while guiding these and other lures around surface obstructions since a high angle helps to hold up a spinnerbait or buzzbait. Also, when using a top water or shallow running lure, a change in the rod angle during the retrieve will help the lure maintain constant action and depth. Thus, a high rod is necessary at the inception of the retrieve, with the rod gradually being lowered as the lure comes closer.

Erratic retrieves can be made easily by working the rod, varying the turn of the handle on the reel, or a combination of techniques. Fly rodders can do the same thing, twitching the rod tip or carefully, yet erratically, stripping in line with the line hand, or doing both at once.

Most retrieves are best when a number of different techniques are used, varying the motion, speed and movement of any lure with twitches, pauses, jerks, short constant retrieves, or several repeated jerks. The technique is not one that is programmed or formulated, but based strictly on experience and judgement.

Most anglers make larger lure movements than optimal and also retrieve lures too fast. A wide sweep with a rod moves a jig three or more feet in the water and completely away from a curious fish. A tiny twitch of the rod, however, will move the same jig only a few inches, often causing a strike. This type of very slight movement is particularly important when working those lures that have no intrinsic action such as flies and bugs, some structure spoons, top water lures, soft plastic worms, other soft plastic lures, and jigs.

The type of movement best used is easily seen when working top lures in calm water. Also, with the decreased stretch in line and increased stiffness and sensitivity in rods today, delicate movements to create the best action become even more important.

Some lures require a regular rhythmic retrieve for best results. An example is when working a jig down a rock cliff or series of rock piles (rip rap) or when working a plain cigar-shaped stick bait on the surface. For the former, a high rod with a short jerk interspersed with a short retrieve of line works best. For the latter, the same type of retrieve with the rod held horizontally or at a low angle works best.

Lure retrieve must also be dependent upon the natural bait that the lure is imitating, when such imitation is clear. A fly rodders nymph might be fished in a stream with only minimal movement so that the nymph imitates an emerging (rising through the water to the surface) insect in a natural state. A sonic imitation cast to schooling bass must be moved rapidly and erratically to properly imitate the nervous movement of schools of shad that the bass feed upon. A crayfish plug must be worked along the bottom in a slow deliberate, hopping movement that will simulate the backward movement of a crayfish.

Drag

Drag is the unnatural movement of a lure in the water, resulting from resistance, pressure, or drag of the line against the water and resulting in slowed, fast or unnatural lure movement. This drag occurs when fishing in running water or current and is caused by the running water "bellying" the line and pulling the lure unnaturally.

The only way to cope with drag is to avoid it by casting upstream or downstream to avoid the pressure against line stretching across the current. Drag, or line pressure, can destroy a good presentation since it makes an otherwise good imitative artificial bait appear unnatural. Often a rod held at a high angle will help reduce the line drag when casting across current. Fly anglers can master and use a "lazy S" cast that throws slack line in the cast that will wash out before the current affects the fly or bug.

Trolling

Basic Trolling

Trolling in its simplest form is nothing more than allowing a lure to trail behind a moving boat. Trolling can be used for any fish that will actively strike a lure in both fresh and salt water.

Trolling can involve bait or lures, with the lures consisting of trolling spoons, plugs, hose lures, soft plastic lures, bucktails, and flies in single or multiple rigs. Baits generally include belly strips, whole baitfish, squid, minnows, cut bait fish, and various combinations and variations of these.

In trolling, the baits or lures generally run straight off the rods. To keep the lures or baits from tangling, different lengths of line are played out and/or varying sinker weights are used to keep the lures separated.

Trolling is best in areas that are known as fish producing areas by making regular, systematic runs to thoroughly cover the area. Fresh water trolling involves fishing deep, while in much salt water trolling, the lure is kept on the surface for sharks, wahoo, sailfish, marlin, dolphin and similar ocean fish.

For simple deep trolling, a number of methods are used. One way of getting deep is to use wire line on special narrow spool reels, carefully paying out the line until the lure bounces on the bottom or reaches a certain depth. Sinkers can be used with wire line for extra depth or with mono or Dacron line. In these cases, the sinkers are generally rigged in one or two ways, using a drop rig in which a sinker is dropped from a short (one to two feet) line off a three way swivel between the line and long leader, or using an in-line sinker between the line and long leader. Often in-line sinkers are keel shaped to prevent line twisting by the lure or bait. Depending upon the depth, line test and boat speed, sinkers can vary from a fraction of an ounce to almost a pound.

Since trolling depth is often controlled by the length of line out, many anglers will use tape, felt tip markings, tight knotted rubber bands, dental floss or other markers on the line to mark the exact length of line that is to be played out with a given rod and lure combination.

Fish often hit when turns are made, presumably as a result of the fluttering action or slowed action of the lures during this maneuver. Care must be taken, however, to make slow wide turns so as not to tangle lines or lures.

For slow freshwater trolling, particularly for walleye, a method of running the boat backward is used to slow the action. The surface area of the stern slows the boat and allows a very slow action and movement of the lure along the bottom.

Specialized and Advanced Trolling

Motor Plates

These fit onto the lower unit of most inboard/outboard or outboard engines. They are usually spring loaded and hinged to further slow the boat, yet flip out of the way at high speeds not to impede cruising speed.

Wire Line and Lead Core Line

These lines are difficult to handle, yet do allow the deepest possible trolling with any lure. The wire line is made of single strand wire. Lead core line will also go deep and is made of a lead center (like fuse wire) covered by a braided core of nylon or dacron for strength.

Planers

Planers are designed to dive and take a lure down. They come in different sizes and styles. All have a mechanism by which the diving angle is changed when a fish hits. This allows comfortable playing of the fish. Planers are tied to the end of the line with a long leader (10 to 40 feet) running from the planer to the lure or bait. When using these or trolling sinkers, the fish must be landed by pulling in the line by hand for the length of the leader.

Teasers

Teasers originally were large, skirted, noisy surface lures designed for offshore trolling to attract large ocean fish. Today, many are fitted with hooks since many fish strike the teasers, rather than the lure or bait.

Side Planers

These greatly expand the trolling area of a boat. They work just like planers, only floating on the surface and planing to the side of the boat. As a result, many more lines can be run than would be normally possible.

Downriggers

These specialized trolling aids are widely used in the Great Lakes and many other areas for light tackle, deep water fishing. Basically, they consist of a reel of heavy wire cable mounted on the gunnel or transom by which a heavy lead weight can be lowered to any depth. Extension poles allow these downriggers to be placed to the side of the boat or off transom and clear of any motor or prop.

Special clips that allow the release of line are fastened to the weight or cable, the fishing line clipped into these devices. The whole device—weight on the cable with the line clips holding the fishing line and lure—is lowered to the desired depth. When a fish hits, the fishing line is pulled from the line clip.

Outriggers

These consist of poles, usually one on each side of the boat. They are primarily used on larger offshore fishing boats, but smaller sizes are available for smaller boats. Lengths range from 12 to 20 feet. They are hinged at the boat so that they can be stored vertically for docking or at a 45 degree angle for fishing. A continuous loop of line runs from the pole tip to the boat so that release clips can be run to the end of the pole or to any intermediate point.

The fishing line is fastened to the release clip and run out the pole. This allows the spreading of the baits or lures over a much wider area from the boat than would be otherwise possible and also allows the use of surface baits much further astern.

Kites

Kites are used in much the same way as are outriggers, but can be used for both trolling and still fishing or drifting. The release clips are attached to the kite line and run up the line to place a lure or bait far away from the boat. Often live baits are fished this way since the bait can be kept on the surface where its frantic struggles help to attract game fish. When the fish hits, the line is pulled from the release clip.

LESSON 16

Fishing from Boats

LESSON

16

Fishing from Boats

Lesson Objectives

Following this lesson students will:

1. Be aware of the advantages of fishing from boats.
2. Know the types of fishing boats available and which ones are best suited to different types of water.
3. Be familiar with propulsion methods.
4. Understand proper methods of trailering and launching boats.

Materials for the Lesson

1. Overhead transparencies and photocopies of graphics on boat hulls.
2. A boat equipped with both a gasoline and an electric trolling motor, if possible.

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TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
	1. Introduce class to the lesson objectives.
I. Why Fish from Boats	2. Begin by discussing the advantages and disadvantages of fishing from boats and writing students responses on the chalkboard.
II. Types of Boats A. Canoe B. Skiff C. Cathedral hull D. Deep V E. John F. Bass	3. Utilizing the overhead transparencies and the photocopied material, lead a discussion of the various types of boats, their advantages and disadvantages, costs, and uses. These are fully explained in the text material and some of the students or their parents may own one or more of them.
III. Propulsion Methods A. Outboards B. Inboards C. Inboard/Outboard D. Electric motor E. Paddles and oars	4. Discuss the different methods of boat propulsion and the advantages, disadvantages, and particular uses of each of the several types. 5. If one or more boats is available for use, have the students attempt to categorize the hull, based on the class discussion, discuss its best use and water it is suited for. Point out storage areas and how the boat is arranged for its intended use and equipment and tackle storage. Discuss the gasoline and electric motors and their size and use in relation to the size of the boat.
IV. Boat Maintenance and Storage	6. Discuss maintenance of the boat(s) and how it (they) should be stored
V. Trailering	7. Explain the importance of proper hitches and safety chains and show those on the demonstration boat. Have the owner discuss factors in trailering a boat safely and how to launch the boat properly. Show the tie down straps, the light connection, and the motor support (used by large engines while trailering) and its importance.

INTRODUCTION

Boats greatly expand the area available for fishing. In their purest and simplest form, they are nothing more than a platform upon which to stand while fishing. Without a boat, an angler's range is limited by his ability to wade shallow waters or by available bank space.

Since anglers fish water conditions and areas that may not normally be used for pure boating or recreational pleasure use, boats for anglers must be built for specific water types and fishing conditions. In addition, propulsion methods must vary. In some cases, the best propulsion is by paddle, oar or pole, while in others a high horsepower outboard or inboard/outboard (I/O) is a must to cover a lot of distance. In addition, boat styles for fishing are constantly evolving and being improved. The bass boat of 15 years ago is not at all like the modern bass boat manufactured for serious fishing today.

Anyone with a boat, or using a boat, must have respect for the craft and maintain and store it properly. In addition, some boats are trailered to different fishing spots, requiring knowledge of driving methods and trailer maintenance.

NARRATIVE

Why Fish from Boats

Boats greatly expand the range of fishable waters for anglers. Without a boat, it is possible to fish only within a cast length from the shore or to wade shallow rivers, streams and ponds. In essence, a boat provides a fishing platform away from shore, an extension of the fishing pier, fishing jetty or other shore bound efforts to extend the range of anglers.

In addition, boats provide far greater movability and maneuverability to cover fishable water. On a lake, any part of the lake (withing safety considerations and legal limits) is within easy range of the angler. To get to a new fishing spot, a mile away is only a few minutes run in most boats. For a shorebound angler, to reach that same spot would require a long difficult walk or be completely inaccessible.

In addition, boats allow anglers to carry a larger variety of tackle than would be possible with most shore fishing. Boats allow for easy storage and transport of extra rods and reels, tackle boxes, lures and varieties of bait, extra clothing for inclement weather, and boating equipment (depth finders, temperature meters) that will aid in locating fish or finding good fishing areas.

The best boat for a fishing experience depends upon a number of factors, including the size of the body of water, the water conditions, the type of fishing, the number of anglers, budget and individual preference of boat length, hull style and method of propulsion. An offshore big game fisherman requires a large offshore 35 foot or larger fishing craft capable of running 70 or more miles, trolling all day and returning to dock. A shallow river smallmouth fisherman is satisfied with a canoe or river-style john boat for drifting currents and eddies. A lake largemouth bass fisherman needs a larger boat with an outboard engine. A serious tournament type bass fisherman wants a high horsepower specialty bass boat. Walleye and striper fishermen might require a larger launch type boat that holds up to four anglers and can be fitted with multiple rod racks and downriggers.

Boat Types

Types of boats suitable for fishing include:

Canoes

These are truly American boats, developed from Indian craft and ideal for fishing rivers, streams, ponds, and small lakes. A well built canoe is not the tipsy craft often depicted but is different and does not have the room that other boats and craft have. Canoes range from short 13 footers to 20 foot freight and "war" canoes, with most anglers opting for 15 to 18 foot craft, an ideal size for two anglers.

Most canoes do not have storage compartments and are best propelled by paddles, a pole, or a very small outboard. For any type of motorized propulsion, special brackets are made for double-end canoes, although for those using this propulsion extensively, square stern models are available for mounting a motor. Canoes are best for quietly and thoroughly exploring fishing water at close range, not for wide range fishing over large lakes. Also, while extremely seaworthy when controlled by an experienced canoeist, they should not be used on big water or water susceptible to sudden weather changes or rough waves.

Skiff

The term skiff is often used for any small boat or craft with a pointed bow, square stern or transom, and a relatively flat bottom. They often go by the term rowboats and are used for rowing or with small outboards as propulsion. They range from about eight to 20 feet long with most in the 12 to 16 foot range. Most are flat bottomed, although they may be slightly rounded.

Skiffs are often found in rental fishing and marina operations, and are designed for two to three anglers fishing in quiet water and at short distances from the dock. They can be made of wood, fiberglass or aluminum, commercially manufactured or home made for pond and river fishing. Their main advantage is that skiffs are roomy and inexpensive.

Cathedral Hull Boats

These boats have two or three distinct hull sections. They are often called cathedral hulls since to look at them out of the water from the bow to stern reveals one arching catherdral opening (made from the two separate hull sections) or two cathedral openings (made from two side and one center hull section). These boats are stable even at rest, wide for optimal fishing or recreational use, and soft riding, planing on the froth in the cathedral archway thrown up by the hull sections.

These boats are made for high horsepower, get up on plane, and ride on a small pad of hull just forward of the transom. They were more popular in the immediate past than they are now, with deep V and other specialty hulls replacing them. Most of these boats come in 14 to 20 foot lengths with 16 to 18 foot craft the most popular. Most are run with outboards although I/O (Inboard/Outboard) are also popular. As a result of their relatively square shape made possible by the use of the unique hull, they have room for anglers, rods, tackle boxes, and accessories.

Deep V Craft

These are boats that have single hulls. The hull is shaped in a "V" for cutting through rough water and for high speed operation. Because of this, these boats have a double hull (the hull in contact with the water and the level deck upon which one walks) making them safe and also often placing the deck above the waterline. Because of the deep V and pointed bow which is flared, they are "dry", even in rough water.

They are designed as planing hulls, riding on top of the water on a small pad of hull forward of the transom. Because the deep V hull construction is less stable when the boat is at rest, they are not as comfortable for drift or anchored fishing in rough water. They can be as small as 15 feet, as in a bass boat design, or up to the largest offshore boats. Smaller ones can be outboard or I/O powered, but all the larger ones are inboard powered, usually with twin engines for maximum maneuverability.

John Boats

John boats, also spelled "jon," are simple, usually wood or aluminum boats that range from eight to 16 feet with have a simple square bow and almost rectangular hulls. As such, they provide maximum fishing space, contain room for fishing tackle and accessories and have a shallow draft. They are usually propelled by small outboards, electric motors, poles, paddles or oars.

Because of the square bow, they will not take and should not be used in rough water or on very big bodies of water. They are stable and are ideal for small lakes, ponds, rivers and stream drift fishing.

Bass Boats

Bass boats are basically deep V boats. While primarily for bass fishing, they are also ideal for other freshwater fishing and some light tackle, inshore salt water fishing.

They are designed for high horsepower and range 15 to 20 feet in length. Most are fully equipped with live wells, rod lockers, dry storage, built-in docking lines, pedestal seats, high horsepower outboards, bow mount electric motors, depth finders, temperature meters, night fishing lights, and consoles. They are designed for big water and cannot be used in shallow, rocky, river type situations.

Specialty Boats

In addition to the general categories above, there are also specialty craft designed for fishing. These include very small pond fishing boats, usually 8 to 10 feet long, with a blunt bow, minimum space, and designed for one or two anglers to be run with very small outboard or electric motors. They are ideal for small, quiet water, are inexpensive and easy to haul on a car top, but cannot take any kind of rough water.

Fold-down boats are also ideal for recreational vehicle (RV) fishermen carrying their gear into remote places. These boats fold flat or into small packages for easy storage. They are seaworthy with small engines and suitable for much fresh water fishing.

Boat Hull Style

The best boat hull style is governed by the intended use of the boat, the size and type of water, the number of anglers and the type of fish. Usually water type is the main governing factor. Small streams, shallow rivers and ponds can be handled effectively by john boats, small skiffs and canoes. Larger waters that might develop rough waves require the use of larger skiffs, bass boats, and perhaps even larger deep V or cathedral hull boats.

In addition to the hull design and length of the boat, fishing boats are often characterized by interior fittings specifically designed for the sport. An extreme example of this is in the fittings and interior compartments that come with a standard fiberglass deep V bass boat. Another example is the large cockpit and wide gunnel boats designed for big water and holding downriggers that are used for Great Lakes trolling.

Motor plates for slow trolling, downriggers, outriggers, side planers, depth finders in graph, flasher or liquid crystal display (LCD) style, temperature meters, live wells, and built-in lure and tackle storage can be added to many boats. Some larger boats even have specialized refinements such as tuna towers to spot fish, flying bridges for extra control when fighting a fish, and loran to return to fishing locations.

Methods of Boat Propulsion

To be effective, boats must be capable of being moved. This can be accomplished by high horsepower engines or a simple paddle, pole or oar. Outboard engines range in size from tiny 1 hp kickers to giant engines of over 200 hp. The maximum size used on each boat is controlled by the recommendation for that boat, found on a BIA plate on the boat. Outboards have the advantage in that they can be used on almost any boat (smaller engines are portable and can be used on rental boats also), are easy to operate, and offer instant power. Sizes are available for canoes and small john boats. Small outboards are usually controlled and run with a combination throttle/steering handle while larger outboards are controlled by cable operated steering wheels at a console.

Inboard engines are found only on larger boats and consist of a regular marine engine mounted inside the hull of the boat with a propeller shaft running at a slight angle from the engine through a watertight seal in the hull to the propeller. Many larger boats have two inboard engines, running two propellers, each with a separate control, for maximum boat control in steering, backing up and docking.

Electric motors are designed for either stern or bow use. For large horsepower boats, they are used on the bow as a controlling or fishing motor once the fishing area is reached. The small electric, which runs on battery power, allows enough control to move the boat into fishing positions, something not easily accomplished with the larger and noisier outboard engine. Stern mount electrics are used for the main propulsion of small boats and in those waters where gasoline operated outboards are not allowed.

Electric motors can be operated by a handle, as can a small outboard, or when in a bow mount configuration, by a foot or electronic operated control that allow the hands free for fishing.

Electric motors have the motor in a watertight lower unit housing, with the controls run from the top and power supplied by 12 or 24 volt batteries. For best results, most manufacturers recommend "deep cycle" batteries that sustain a continued electric drain.

Inboard/outboard engines combine the features of both types of propulsion. The engine is mounted in the boat, usually immediately forward of the transom. The power goes through the stern of the boat and into an angled, outboard-like lower unit that holds the propellor. It has the advantage of offering higher horsepower performance in less space and less draft than the prop from a true inboard engine. The lower unit can also be lifted with a power lift, making it better for shallow water application.

Paddles are primarily used for canoeing, but a paddle or set of oars is required in many states as part of a safety emergency package. Oars are used primarily in skiffs where they are an effective, but slow means of propulsion.

A pole—sometimes called a setting pole—is primarily used in river fishing with a canoe or jon boat. In shallow water a pole offers better and quicker control than either a paddle or oar. A pole is also widely used in some salt water fishing as in sight fishing (fishing to spotted fish) on the Florida or other tropical flats.

In all fishing boats, care must be taken with the accessories, occupants and occupants' gear to distribute it carefully so that the boat is not unbalanced. Imbalances make the boat difficult to handle in any water and can be dangerous.

In all situations, boating safety must be observed. (See more on this in Lesson XVII—Boat And Water Safety). This means limiting the boat to the recommended weight, contents and number of passengers and engine size. Information on the recommended weight and passengers and the maximum horsepower engine can be found on a "BIA" plate on all boats. This plate includes recommendations of the Boating Industry Association, a self regulatory boating industry body formed in part to keep boating safe.

Safe boating also means knowing all the boating regulations, rules of the road, safety procedures, not running a boat while under the influence of alcohol, not allowing anyone to ride on the bow, and wearing a PFD at all times the boat is operating under power.

Boat Maintenance and Storage

Boats and equipment must be maintained and stored properly. Proper maintenance includes a careful inspection of the boat on a regular basis, preferably after each trip. The hull, engine, and accessories should be checked for wear or damage. Fiberglass and aluminum boats require little maintenance. Aluminum boats should be checked for cracks, severe dents, loose rivets, signs of leaking, and structural strength of the ribs and stringers.

Fiberglass boats should be checked for leakage or spiderweb cracks in the hull. Wood boats must be checked extensively and regularly for soundness of the wood, loss of caulking, and tightness of screws and fasteners.

Engines come with an owner's manual that indicates checking, maintenance, and lubrication schedules. These should be carefully followed, with logs kept as to the boat use since engine maintenance scheduling is based on hours of use. Of particular importance is the change of lower unit lubrication or grease since lack of lubrication can ruin an engine quickly.

When not used, boats must be stored. Boats kept at a boat slip or dock must be tied, taking into consideration sufficient slack to allow for tidal changes in salt water areas. Boat fenders should be used to protect the boat. Trailered boats must be loaded onto a trailer fitted for the boat so that the hull is supported adequately. Car-topped boats must be carried with sturdy racks and adequate tie-downs. At home, car top boats must be stored with sufficient support, based on the type of hull design. As a general rule, most small boats are best stored upside down on saw horses or on similar racks.

In areas where the water freezes, all boats must be taken out of the water for proper storage or the slip equipped with bubbles to prevent freeze-up from damaging the boat. Bubblers create a concentrated stream of bubbles to prevent ice from forming around the boat.

Boat Trailering

Boat trailering is a seldom appreciated but vitally important skill for those fishermen with larger craft that are towed. Trailering requires a trailer designed for the boat length and weight and with rollers or slide bars. A good hitch, safety chains and light hook ups are required on all trailers.

Safety procedures must be observed during trailering. Any car and trailer combination requires far more time and clearance when passing another vehicle. On a left hand turn, the towing vehicle should hug the shoulder to prevent the trailer from going over the centerline. On a right hand curve, it should hug the centerline to prevent the trailer from going onto the shoulder.

Backing up at a launch ramp is easy, provided that a simple rule is followed. One rule states that the driver move the car wheel the same direction that the trailer needs to go. Another simple rule suggests holding the steering wheel by the bottom and turning it in the direction the trailer must go. Both of these tips accomplish the same thing; they are just different ways to think of the same basic concept. The best launching involves lining the car and trailer up straight with the ramp to avoid any difficult turns.

Before launching, load the boat completely with all fishing tackle accessories, boating gear, and life preservers. The boat tie-down strap must be released, the tail light connection separated, the engine raised, and a line attached to the boat cleat held by someone on shore to secure the boat and to bring it to the dock after launch. Once the boat is launched, the car and trailer are pulled away and the boat pulled to shore or toward the dock for boarding.

LESSON 17

Boat and Water Safety

LESSON

17

Boat and Water Safety

Lesson Objectives

Following this lesson students will:

1. Understand how to safely operate a boat.
2. Know what agencies are available for assistance in time of trouble.
3. Know what should be included in a boat readiness checklist.
4. Be familiar with basic boating equipment and safety gear, and how to store it on a boat.
5. Know how to cope with basic boating emergencies.
6. Be able to recognize severe or dangerous weather and know how to handle a boat in such conditions.
7. Understand the need to wear a realiable Personal Flotation Device (PFD) while boating.

Materials for the Lesson

1. A chart showing a coastline, channels, underwater contours or depths, and navigational aids.
2. Free materials from the U.S. Coast Guard, local Power Squadron, Red Cross, Coast Guard Auxiliary, or state boating agency.
3. A simple compass that can be handled by students together with a chart.
4. A tide table to teach tides, if needed in your area.
5. Several types of PFD's.
6. A sample float plan.
7. A localized, individualized boating check list.
8. Examples of anchors, anchor chains, and lines.
9. Examples of fire extinguishers, horns or whistles, flares and other emergency equipment.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	Much of this lesson is suited to teaching at a dock or location with a boat available. If this is not possible, a second meeting to follow up on the concepts presented and to present an opportunity for the students to experience and practice safe boating techniques should be explored. Also, this lesson lends itself to the use of one or more qualified boating instructors as resource people. 1. Introduce class to the lesson objectives. 2. Begin with a discussion of the need for proper and safe boat handling and safety on the water. For anglers, learning how to use a boat safely is just as necessary as knowing how to operate a bicycle or car in a safe manner. The National Safety Council statistics on drowning indicate that it is the second leading cause of accidental death for people up to 44 years of age; second only to automobile accidents. Six to eight thousand people drown each year and most of these are very close to safety. Safety is paramount.
II. Basic Boat Handling A. Rules of the Road	3. Discuss boat handling and how boats differ from land-based vehicles in speed control, steering, and starting and stopping. Boating and speed in restricted/protected areas must be included as well as respecting the rights of others to share the resource. 4. Just as there are rules for driving a bicycle or car, there are some basic "rules of the road" on water. Use the photocopied graphics from the appendix to discuss these basic rules. Include approaching, overtaking, and right-of way of boats. Horn and whistle signals, found in booklets of Coast Guard and others will be helpful here.
B. Navigation	5. Just as automobile drivers use maps to navigate, boaters navigate by using key checkpoints on the shore, sophisticated electronics equipment, or by using charts and a compass.

Lesson Content Outline	Classroom Procedure
III. Boat Readiness Check A. Float Plan B. Check List 1. Registration 2. Fishing License 3. Fuel 4. Fire Extinguisher 5. Lights 6. Flares 7. Battery 8. Ropes 9. Paddle/Oars 10. PFD's	6. Written float plans should be left in the event of an emergency or if the angler does not return on time. The float plan should include boating plans, return time, course on the water and ultimate destination. With a lake map or chart, discuss a specific float plan with the students. 7. Ask the students what they think should be included in a boat readiness checklist for angling in your area. As the list develops, discuss why each of the items is important. Stress how the use of a checklist can help the boater remember needed items before an emergency arises.
IV. Coast Guard, State Police, Local Police	8. Discuss the role of the Coast Guard and other agencies in enforcing boating regulations and in ensuring that bodies of water remain safe.
V. Storms A. Lightning B. Wind and Waves C. Fog	9. Ask the students if they have ever been caught on the water during a storm, if they were afraid, and how the situation was handled. Stress the importance of leaving the water, if possible, before a storm strikes. Discuss in detail what to do in the event of lightning, strong wind and waves, and fog. An experienced boater or Coast Guard representative would be a good resource.
VI. Equipment Storage A. Boating Equipment B. Fishing Tackle	10. No matter how large the boat, it seems that there is never enough room. Discuss the importance of boat storage along with safety aspects of an uncluttered boat and knowing where needed items are in the event of an emergency. The location of gasoline cans and batteries, PFD's, and fire extinguishers, along with rods and reels and other fishing tackle is crucial to a pleasant boating and fishing experience.
VII. Anchors A. Types B. Uses	11. Utilize the graphics in the apprendix and a prepared overhead transparency or photocopied handouts to discuss boat anchors, their uses (including emergency situations), and types popular in the area. Include the use of "sea anchors."
VIII. Maps, Charts, Compass	12. Discuss the importance of using a compass in conjunction with a chart for water travel. With a young class, include just a basic discussion; with an older group or if angling is done on large bodies of water in your area, expand the discussion so that all students would be able to navigate.
IX. Tool Kits, Tools, Parts	13. Discuss the importance of carrying tools and spare parts on a boat. The complexity of these will be determined by the boat and equipment. Suggest what is necessary for a large, complex boat vs. a small boat.
X. Emergency Procedures A. Capsizing B. Alcohol C. Person in the Water	14. Emergencies on the water can be terrifying experiences. They can occur from unsafe handling of the boat, from drinking alcoholic beverages, or from unknown hazards. Discuss emergency procedures including the use of PFD's and the concept of reach, throw, row, go to save someone in trouble in the water. It is important that students understand that they swim out to save someone only if they are trained in lifesaving. All other methods of lifesaving should be tried first.

Lesson Content Outline	Classroom Procedure
XI. Security	15. Ask students how they or their parents insure the security of their boats and fishing equipment. Many of the items on and in boats are a temptation to theives and these must be secured to prevent loss.
XII. Courtesy	16. With the tremendous pressure on our water resources, courtesy is extremely important. Ask the students to make a list of the ways they can be courteous on the water. The Golden Rule is a good way to lead into this discussion.

INTRODUCTION

Learning how to safely use a boat is as necessary as learning how to ride a bike or to drive a car safely. Boat handling and safety is dependent upon an understanding of boat operation and "Rules of the Road" which regulate boat traffic. Navigation skills are also important, especially in larger boats in open water.

Just as local and state police help on the road, the Coast Guard helps boaters in emergencies.

Storms can make boating very hazardous, and boating should be avoided in these situations. Especially dangerous are lightning, the waves that result from strong wind, and fog.

Since boats rock and bounce in the water, proper storage of both boating and fishing equipment is a must, both to prevent injury to passengers and damage to the equipment. Each piece of equipment should have a special storage area, making that equipment easy to find and use.

Boating also requires knowledge of anchors, anchoring, PFD's, maps, charts, docking and mooring, emergency procedures, and security. Especially important is the realization that while boating is fun, alcohol and boating do not mix.

NARRATIVE

Basic Boat Handling

Operation of a boat is similar to, yet very different from operation of a car. The two basic controls are control of speed (acceleration or deceleration) and control of direction (steering), along with braking when necessary. Larger boats are controlled by a steering wheel and smaller boats by turning the throttle handle on the outboard or by using oars, paddles or pole. There are no brakes on a boat. The accelerator is usually in the form of a lever operator throttle, although some boats are now being equipped with foot controls, not unlike those used on cars.

The steering wheel works the same way, but a boat will react differently than a car. In a car, steering is controlled by the turning of the front wheels, with the rear of the car following almost the same course as the front wheels. In a boat, steering is controlled by turning the propeller (as in an outboard or I/O boat) or turning a rudder (as in an inboard boat). Thus, a boat will swing widely to the stern since the control is at that point. This basic difference is important for maneuvering in tight places, such as docking and mooring.

Since there are no brakes, all boats will drift to a stop, with water resistance rapidly slowing the boat. For emergencies, a boat can be placed in reverse to slow and stop it.

To prevent accidents and make boating enjoyable and safe, several rules of the road must be observed. An operator is considered in violation of boating laws if these rules are not followed. Negligent operation includes speeding, operating a boat in protected, swimming water or slow speed areas, and skiing too close to swimmers or fishermen, thereby causing waves to other boats or docking areas. Taking the right away from a sailboat, anchoring in a shipping channel, overloading beyond the weight or number of passengers recommended by the boat manufacturer, and lacking proper boating equipment or safety gear is also dangerous. Running at night without proper lights, overpowering the boat with an engine exceeding that recommended by the manufacturer, and operating under the influence of alcohol can also lead to serious accidents.

Basic operation includes knowing how to operate the boat and observing safety rules. These rules of the road include: Boats approaching each other must stay to the right at all times. Overtaking another boat can be done on either side of the boat but must be accomplished at reduced speed. Any boat off the starboard bow (right side) from a point directly ahead to a point just aft of amidships has the right of way (just like two cars at an unmarked intersection, when the car to the right has the right of way).

In most cases, there are a series of standard horn and whistle signals for these meetings so that the other boat will know the intentions. These regulations and others are usually found in booklets offered by state boating agencies or by the Coast Guard.

Navigation is important in all boating and involves ways to go from one point to another on open water. Navigation methods can involve sophisticated electronics, such as Loran C, a device that allows the boater to locate an exact spot on the water; using charts and compass headings; and using visual sightings for in-close navigation. Loran is very expensive, though becoming less so, and visual sightings are reliable only during daylight hours in clear weather.

The best navigation is accomplished using charts and compass (more about this latter), orienting the chart to a starting position, and following certain compass courses to reach a destination. For this, a good, properly mounted boat compass is a must, along with basic navigation skills, such as running time-distance courses, which will place the boat at a certain spot based on running speed and the time taken to get there.

Boat Float Plan

All boaters should file a float plan for each trip. A float plan is a description of return time, course, and destination. This plan is left with a family member, friend or marina for information on the boat's whereabouts, should an emergency arise. Float plans can be verbal but are best when written in order to avoid mistakes or confusion.

Boat Readiness Check

Check lists for a boat are also important and allow for easy checking of a boat before any trip. While a check list can be comprehensive, certain basics should be included. Also Coast Guard regulations specify that certain accessory equipment be carried on boats of certain lengths. Be sure to check the regulations. The classes of boats involved are Class A, boats 16 feet in length and under; Class I, boats 16 to 26 feet; and Class II, boats over 26 feet. Be sure, also, to check state and local categories and requirements.

A possible check list might include:

Registration

Boats must be registered. In some states all boats, including competition white water kayaks, must be registered. In others, only larger boats or boats with engines or engines over a certain horsepower must be registered. In all cases, the boat must be numbered and a registration certificate carried with the boat at all times.

Insurance

The boat owner and/or operator is legally responsible for damage or injury that might be caused while boating. Thus, insurance is recommended, and the appropriate information should be carried with the boat.

Fishing Licenses

These must be carried on board in all fishing situations, in accordance with state laws.

Fuel

Fuel tanks must be topped off for boating excursions. They must be comensurate with the boat and engine size and adequate for the trips planned. Larger boats have built in tanks, although portable tanks can be used to supplement these.

Fire Extinguishers

All boats should be equipped with a Coast Guard-approved fire extinguisher. This should be a BC type for use on electrical and gasoline fires. They are required on larger boats and on smaller boats in some states and areas. They are required on Class A and Class I closed motorboats by the Coast Guard.

Lights

Boats which are to be used at night must have a red (port) and green (starboard) light and a 180 degree white light.

Flares

Certain size boats used at night must also carry flares. Daytime flares are required on larger boats.

Sound Signaling Device

Class I boats are required to carry a horn or whistle that is hand, mouth or power operated. This is recommended for Class A boats.

PFD's

Personal Floatation Devices are required on all boats. Generally wearable type (PFD Type I, II, or III) are required, along with one Type IV (throwable) for Class I boats.

Paddles or Oars

Most boating regulations require that boats be equipped with an alternate form of propulsion, such as a paddle or set of oars for emergency use.

Ropes

Ropes are not legally required but are necessary for docking, anchoring, mooring, and boat-to-boat contact. Other devices in a checklist for a boat can include spot lights, boat poles, fishing tackle, first aid kits, anchors, anchor ropes, sea anchors, and spare props. The drain plug must also be checked before launching a boat.

In addition, any Coast Guard Auxiliary or United States Power Squadron and some state agencies offer courtesy inspections of boats that will run through a basic check list of necessary equipment and procedures and recommended accessories for the boat.

Coast Guard, State Police, Local Police

The Coast Guard has jurisdiction over coastal waterways and other navigable water. In other areas, the state has jurisdiction, although local interests might control specific water supply reservoirs and waterways. Police have the responsibility to enforce boating regulations and can stop boats to check boat registration, number and condition of PFD's, and fishing licenses.

Storms

Storms can be devastating on the water. Lightning is particularly dangerous since it will often strike the highest point, and usually a boat is the highest point. The best solution is to get off the water if there is a possibility of lightning or storms. No boating or fishing trip is worth the danger. If a storm comes up suddenly or lightning strikes are close, place all rods in the bottom of the boat, including rods in rod holders if these point the rods up. Also remove or store radio antennas, outriggers or any other vertical structures. Stay low, lying down in the boat if necessary and ride out the storm or, if possible, get to land. Once on land, stay low, do not gather fishing rods or gear and do no wait out the storm under trees, light houses, or other high objects. If necessary, lie in a ditch or open field.

Storms are often accompanied with high wind, which is dangerous, but waves also make boating and boat operation difficult. Again, get off of the water at the first sign of a storm to avoid high waves. This also applies to small lakes, ponds, and even rivers since the small craft and john boats used on these waters are not suitable for rough water.

When it is not possible to get off the water before the storm hits, boat operators must be most alert and skillful to prevent waves coming in over the transom or the boat broaching in a wave trough. The best method is to run the boat at an angle to the seas (quartering into the waves) to ride over each wave, even if this requires a tacking course to get to shore. Courses straight into seas are hard on boats, equipment and passengers and make control of the boat very difficult. Courses directly away from seas (following seas) are very dangerous since a loss of boat power or hesitation by a boat operator can result in waves crashing into the boat over the transom.

If a person must ride out a storm, use a long anchor rope and a heavy anchor (if there is a choice). If the anchor drags, be sure that the boat is not be pulled into rocks, shallow water, or rough water that is even more dangerous. If an anchor is not available and one has a dead engine or cannot proceed, use a sea anchor. A sea anchor is like a parachute and will not hold a boat stationary but will hold the bow into the current or wind to better ride it out. Lacking a proper sea anchor, use anything that floats, such as spare PFD's (Not any that are required for passengers, however), an ice chest or an empty gas can.

Fog is also very dangerous since it is impossible to see. It is best to avoid fog situations. If that is impossible, use an audible signal to indicate boat position to other boats. Fog requires that a five second audible blast or signal be given each minute. When it is necessary to boat in a fog, use a compass and chart to properly navigate since visual navigation will be impaired.

Storage of Equipment

There is never enough room on a boat for equipment. However, with good planning, storage of equipment is possible and will prevent dangerous cluttering situations. Boats should not be overcrowded or cluttered. Life preservers should be instantly available and stored where they can be instantly reached. Gasoline cans should be placed in the rear or away from tackle and food. Anchors should be stowed in the bow, in anchor chocks or in lockers with the anchor rope coiled neatly for instant use.

Gas cans and batteries should be clamped in suitable brackets or held down with bungee cords. All gear should be stored so that it does not blow out when underway. Boat hooks should be stored in special clips out of the way or racked so that they do not roll around. Often boat fenders can be stored in lockers, as can much other spare gear.

Fishing tackle poses unique problems for storage. Fishing rods are best stored in a rod rack. These can include racks for big game rods in the cabins of large boats, vertical rod racks in medium size boats and horizontal racks in small boats. If possible, all rigged rods should be held in these racks, both to prevent damage to the tackle and injury to passengers.

Landing nets and gaffs should be stored in special racks, also, by using special clips available for these accessories. Tackle boxes should be tied down or wedged in place.

Anchors and Anchoring Equipment

Every boat needs an anchor. An anchor is the "parking brake" that allows the boat to stay in one spot. There are many different types of anchors in sizes for various size boats. It is important that an anchor be suitable both for the size of the boat and for the type of bottom.

It is important to have the right anchor and proper length rope. The rope should be a stretchy soft rope, with a length equal to about 10 times that of the bottom depth in which the boat will be anchored. This length of rope out, called "anchor rode," will help to hold the boat securely. Calm water will require little rode; rough water, or current will require more rode.

Anchor types and their uses include:

Danforth type. This has two flat metal flukes that dig into the bottom and hold very well. It is also very light for its size and holding power. Sizes are available for all boats and they work best in most hard (but not rock) bottoms.

Mushroom type. This type looks like an upside-down mushroom and holds small boats well in sandy or muddy bottoms. It is available for small boats and has less holding power than a Danforth. It does not hold well on hard, marl or rocky bottoms.

Navy type. This is a heavy anchor with flukes that dig in and works similar to the Danforth.

Other types of anchors and variations of the above are also available. Often anchors are developed for specific purposes and unique water conditions and may be regionally popular.

Maps, Charts and Compass

Maps are seldom used in boating since, technically, a map shows land areas. Also, a map shows where to go through roads and trails. Charts are used for water travel, and do not indicate land characteristics. Charts are different from maps because they do not indicate where to travel, only dangerous areas to avoid. Charts also have a good compass rose (drawing of a compass and degrees). Many charts also have bearing courses from given launch or marina areas to destinations or popular fishing spots.

A chart must be used with a compass, with the chart oriented to a compass reading and courses taken from the chart and compass for effective navigation. Since a compass will not show the way to go, but will only indicate north, proper use requires taking compass readings throughout a boaing trip so that a reverse (180 degrees) course can be taken for the return to dock.

Tool Kits, Tools, Parts

The need for a tool kit and spare boat parts is dependent upon the size, complexity, and use of the boat. A river fishing canoeist may carry no tool kit or parts. An offshore fishing boat is well advised to carry a complete mechanic's kit (like that of a car mechanic) along with spare parts including plugs, points, spare hoses, and other fittings or engine parts. Those running a small outboard are advised to carry spare plugs, hoses, engine props, and shear and cotter pins for on-the-water repair.

Docking and Mooring

Docking and mooring is a skill just like parking a car. As with parking a car, it is often feared by beginners. Docking varies markedly with different types of docks, sizes of boats and weather conditions, but the basics are all the same. The boat must be slowed and under control. On larger boats, fenders should be placed alongside to cushion docking blows. In calm water, allow the boat to drift into the dock, using power only to control the boat movement or to back it off slightly, if required. If working in current or waves, take the boat into a dock by working into the current for maximum control. If this is impossible, hold the boat in reverse and allow the boat to slowly drift into the dock.

When mooring, both stern and bow lines must be used. With a permanent docking, "spring lines" must be used to hold the boat properly, to prevent undue rubbing of the boat against the dock or pilings, and, if necessary, to allow for tidal flow.

Emergency Procedures

Emergencies require immediate attention. Boating emergencies are rare, but their possibility must be considered at all times. Capsizing or sinking is perhaps the most feared emergency. These can be caused by excessive speed, negligent boat operation, damage to the boat, high seas or storms, unsafe turns, overloading the boat, improper engine trim (angle of engine to boat transom), and striking an underwater object.

Operate all boats safely and avoid those conditions that cause sinking or capsizing. The captain of a sinking or capsized boat can only make sure that all passengers get into PFD's, that radio may-days have been transmitted, and that other boats are alerted visually with flags, waving of arms, and bright clothing.

Man overboard is another emergency that requires immediate attention. In this case, do not go overboard for the rescue—instead throw a PFD (the reason for the required throwable PFD on Class I and larger boats), slow the boat, and bring the boat to the person safely, slowing or killing the engine when approaching alongside. One boat passenger should keep the person in view at all times.

Fire requires immediate extinguishing. A fire extinguisher should be on all boats and of a BC type rated for electrical and gasoline fires. It should be Coast Guard approved. It should be instantly available, near the stern of the boat, but not in the immediate area of the engine, making access difficult or impossible.

Security

All boats and engines should be kept secure at all times to prevent theft. Special locks are available to lock outboard engines on boats, to lock boats on trailers, and to lock trailer tongues shut on vehicle hitches. This is no substitute for constant checking of boats and boating equipment and storing equipment and boats under maximum security. All electronic equipment should be removed from boats when not in use. This equipment is a constant temptation to thieves.

Courtesy

Common sense and courtesy will make everyone's day on the water safer and more enjoyable. Individuals go boating to have fun and that fun can only come if everyone's rights are respected, and if all the rules of boat and water safety are obeyed.

UNIT III

UNDERSTANDING FISH AND THEIR ENVIRONMENT

LESSON 18

Fish Biology

LESSON
18

Fish Biology

Lesson Objectives

Following this lesson students will:

1. Be able to identify several freshwater, saltwater, and anadromous fish.
2. Be able to provide a definition of a fish and discuss its relationship to other vertebrates.
3. Understand basic fish anatomy and how the shape helps determine the specific life style of different species.
4. Be able to identify the fins of a fish and tell how they are used.
5. Understand why a fish has scales and body slime.
6. Know the importance of coloration and countershading.
7. Understand the purpose of gills and the gas (air) bladder.
8. Know how fish swim.

Materials for the Lesson

1. Overhead transparencies and photocopies of the salt and freshwater fish from the graphics.
2. Overhead transparencies and photocopies of the external and internal parts of a fish from the graphics.
3. Models or mounted fish that are popular in the local area.
4. Fish that have been caught in the local area and preserved by icing.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Classification and Identification A. Definition of a fish B. Relationship to other vertebrates C. Identification 1. Freshwater fish 2. Saltwater fish 3. Anadromous fish	You may wish to involve a fisheries biologist or the local high school science teacher in this lesson, especially if the students are older or more experienced anglers. 1. Introduce class to the lesson objectives. 2. Ask the students for a definition of a fish. Depending on their age and experience, the answers will vary. They are cold-blooded vertebrates, with gills and fins, and live in an aquatic environment. 3. Discuss the importance of the lesson to ultimate angling success. The better the angler understands the prey, the greater the chance of catching fish. 4. Using the photocopied materials and the overhead transparencies, discuss saltwater, freshwater, and anadromous fish species. Discuss, compare, and contrast their shapes and sizes and how these factors influence their particular life styles and their relationships with other vertebrates. If models or actual fish are available, show them to the students to assist them in the identification process.
II. Basic Fish Anatomy A. External B. Internal C. Skin 1. Scales 2. Slime 3. Coloration D. Gills and Gas Bladder	5. Using the same instructional aids as above, discuss the various external and internal parts of a fish. Name the respective fins and discuss how they are used. Point out the scales (on certain species) and what they are for. Point out the gills and air bladder and their particular functions. 6. Using models, real fish, or colored pictures (if they are available) discuss the coloration of different fish, how they are countershaded, and why this is important.
III. How Fish Swim	7. Ask students how fish swim and how this differs from humans. 8. Discuss why these factors are important in fishing.

INTRODUCTION

Every angler should be able to visually identify locally popular sport and gamefish. However learning to correctly name the various species requires exposure and practice. Once a particular species has been seen a few times, it should be recognized instantly. Initially, an angler will learn to distinguish between basic differences in bass, catfish, and other species. Then he/she can concentrate on the lesser differences between largemouth and smallmouth bass or channel and flathead catfish.

Successful fishermen target their approach to specific species rather than merely putting a bait in the water and hoping something will strike. One needs to learn to identify fish, but a successful angler must know characteristics and preferences of the species.

Becoming versed in fish anatomy is more than an academic exercise. By looking at the form of a fish, its fin and tail structures and its coloration, one gains insight into its life style. The physical characteristics of a fish are adapted to the habitat it lives in and determines the food it will eat and how it will react. This is all part of the fish-catching process. When the angler knows the quarry, the results speak for themselves.

NARRATIVE

Classification and Identification

Definition of a Fish

Fossils show that fish inhabited the waters of the world more than 400 million years ago, but most of the more than 20–40,000 living species had their origin in the last 100 million years. By definition, a fish is a cold-blooded, aquatic vertebrate (with a backbone) with permanent gills and fins (remember that the tail is considered a fin). Their bodies are supported by a segmented, skeletal frame.

Fish inhabit watery environments from the polar regions to the equator and can survive in depths of a few inches to as much as five miles or more beneath the surface of the sea, providing there is adequate oxygen.

Sport or Game Fish

Sport fish is the term used to describe any species caught for fun with a hook and line. Whether it is subsequently released or kept for food does not alter the definition. The meaning of game fish is not quite as clear. In one sense, it denotes a species that characteristically puts up a strong battle when hooked and brings a feeling of accomplishment to the angler. Virtually all game fish are predators and will take live prey. They can also be caught on artificial lures.

Everything in fishing is relative. When bass, trout, and pike are present, catfish probably would not be classified as a game fish by many fishermen. However, who can convince the youngster struggling to catch a fish that the trophy catfish he just landed is not a game fish. As a rule of thumb, consider that the top predators in any body of water are game fish. However, most fish species are recognized for world record consideration by the International Game Fish Association.

Relation to Other Vertebrates—Food Predation

Along with mammals, birds, reptiles, and amphibians, fish are vertebrates. That means that they have a segmented backbone and a brain enclosed in a braincase or cranium. They are the only vertebrates capable of living underwater continuously without gleaning air from the atmosphere. Fish obtain oxygen that is dissolved in the water passed through their gills.

Through the process of evolution each fish species has adapted to its environment. Although two species may look extremely similar and may be confused during the identification process, their life styles may have marked differences. Whether they graze on microscopic organisms or chase live prey, fish feed on something and, in turn, become food for another species. Nothing below the surface of the water is ever wasted or above predation.

Understanding the primary diet and how a species is positioned in the food chain become vital ingredients for the recreational angler. Furthermore, this information helps in selecting the proper bait. Fish are creatures of habit and exhibit certain behavior patterns. They do not think as humans, but react to certain trigger mechanisms that signal food.

Identification of Common Sport Fish

Fish have two names, a common name and a scientific one. The American Fisheries Society publishes a list of official common and scientific names. However, it is not unusual for a fish to have several common names depending on geographic location, but it can only have one scientific name. The Latin scientific name is in two parts, with the first representing the genus and the second the species. Genus is the main sub-division of a family of fishes and is made up of a small group of closely related species. It is capitalized. The second word refers to only one species and is not capitalized.

The bluegill (*Lepomis macrochirus*), a member of the sunfish family (Centrarchidae), is known by a variety of names that include bream, sun perch, blue sunfish, and copperbelly. The largemouth bass (*Micropterus salmoides*) also belongs to the sunfish family (Centrarchidae) and is sometimes called bigmouth, largemouth, green bass, green trout, Oswego bass, and black bass. There is never any confusion with the scientific name, which refers to a single species. That becomes the final identifying test.

Common names can sometimes deceive the angler. The Atlantic salmon is not really a salmon, but a trout. The brook trout, lake trout, and Dolly Varden trout are all chars and not trout. The walleye is not a pike, but the largest member of the perch family. And, in salt water, the skipjack tuna is actually a mackerel.

In learning to identify fish species, it is natural to gravitate to the accepted common names in a particular geographic area. It's important to know these because other fishermen will be using them. However, it is equally valuable to be familiar with other common names and to recognize that the scientific name removes all doubt.

Identification Methods

Most fishermen learn to identify fish by sight and to rely on certain distinguishing characteristics to separate species. Scientists are much more precise in their methods of identification. An angler can afford to be wrong on occasion, but a researcher cannot. In some cases, one must count the fin rays, which are the bony rods extending into the fins. They can be spiny (hard) or softrayed. Another method is to count scales along the lateral line. As a fish gets bigger, the scales increase in size, but the number stays the same.

There are three ways to measure a fish. Standard length starts at the tip of the snout (mouth closed) and extends to the base of the caudal fin (tail). The fork length starts at the front of the mouth and goes to the tip of the shortest ray of the caudal fin. Finally, total length extends from the mouth to a perpendicular line drawn to the extreme tip of the caudal fin. The depth of the body is measured from the back to the belly at the deepest part. Girth is the measurement around the fish at this point.

Counting gill rakers or fins in the field is a tedious method and not recommended except where identification is critical. For the angler, experience and practice are still the best ways to achieve identification skills.

Freshwater Fish

The ability to identify the fish one sees or catches adds an exciting dimension to angling. With a little practice, almost anyone can achieve this skill. Start with the more common sport fish families in the immediate area. There are similarities among members of the same family as well as differences, and these may prove important in the identification process.

Shape, coloration, fins, mouth, eyes, skin (scaled or smooth), and the presence or absence of certain features often become keys to correctly naming a fish. One should also consider the type of water from which the fish was caught or in which it was seen. Water temperature might also provide a clue since certain species favor colder waters than others.

Among the more common and popular families of fresh water fish, one finds the Trout and Salmon (*Salmonidae*), Sunfish (*Centrarchidae*), Perch (*Percidae*), Pike (*Esocidae*), Catfish (*Ictaluridae*), and Sucker (*Catostomidae*).

Trout and Salmon (Salmonidae)

There are five sub-divisions of the Trout Family that include the trouts, char, Pacific salmon, whitefishes, and grayling. Every member of the Salmonidae family has a somewhat fleshy adipose fin on its back between the dorsal fin and caudal fin (tail) similar to those on catfish. However, catfish have barbels, plus a totally different shape and coloration.

Within the lower 48 states, the whitefishes and grayling have a limited range along the northern tier. Grayling boast a high, sail-like dorsal fin not found on any other fresh water fish. As a general guide, trout have black spots, while char have red spots. Salmon may or may not have black spots. Of the 60 species of trout, rainbows and browns rank as the most common. Cutthroat, identified by the red "slash" mark under the dentary bone, are widely distributed in the West. Remember that brook trout, lake trout, and Dolly Varden trout are all chars. The brook trout has pink or reddish fins lined with white and red spots. Dolly Vardens have red spots, but lake trout may have very pale spots.

Pacific salmon include the Chinook, chum, sockeye, silver, and pink. They are found from California to Alaska and in the Great Lakes. These salmon enter the rivers to spawn, then die. Coloration changes from a bright silver to brilliant hues, depending on the length of time in the river. The body of an Atlantic salmon is five times longer than it is wide. This fish is a trout and not a salmon. Coloration becomes darker the longer the salmon remains in the river, but Atlantic salmon may spawn and then return to the sea.

Sunfish (Centrarchidae)

Thirty species of fish native only to North America comprise the sunfish family. The dorsal fin is the key. All members of this family have a dorsal fin with two parts—a spiny forward portion and a softrayed portion. These are united in a single fin rather than separated.

For identification purposes, the family can be broken down into the sunfishes, which include the bluegill, pumpkinseed, longear, and redbreast; the crappies (white and black); and the black basses which, cover the largemouth, smallmouth, redeye, and spotted bass.

Bluegills rate high on the popularity list and can be identified by the solid black flap on the gill cover and a dark blotch at the back of the dorsal fin. In parts of the U.S., the bluegill and other sunfish are lumped under the name of bream. Each member of this family has special characteristics and identifying features.

To the untrained eye, black and white crappies look similar. The black crappie usually has more dark blotches over its body, while the white crappie has a more silvery shade with black markings formed into 7 to 9 vertical bars. Positive identification may be made by counting the dorsal spines. Black crappies have 7 or 8, while the white crappie only has 6.

The easiest way to tell a largemouth bass from a smallmouth is to look at the jaw. On a largemouth, the jaw extends beyond the eye, while the jaw of a smallmouth extends just behind the *pupil* of the eye. For a final confirmation, check the dorsal fin. Smallmouths have a shallow notch between the spiny and softrayed sections, while the largemouth as a pronounced dip reaching almost to the back.

Perch

Yellow perch, walleye, and sauger are members of the perch family and are widely distributed. Yellow perch have dark backs, yellowish to golden sides, and darker bands from the back to around the lateral line. The dorsal is split and the fish has an elongated body.

Walleye and sauger are difficult to tell apart. Their bodies are round and elongated with slightly forked tails. The eyes look glassy, as if they have a mucous coating over them, and the mouth has sharp teeth. Coloration ranges from white on the belly to olive green on the sides. The tail of the walleye has a silver or white tip, while that of the sauger does not.

Pike

The pike family includes the chain pickerel, redfin pickerel, grass pickerel, northern pike, and muskellunge. Members of this family have long, relatively slim bodies with the dorsal fin set well back and close to the forked tail. It is usually just above the anal fin. All pike have teeth and elongated snouts. The chain pickerel is larger that the other two pickerel species and has black, chain-like markings on its side.

The northern pike has bean-shaped spots on its side and dark spots on fins and tail. The musky offers a barred look in coloration. Bars are vertical markings and stripes are horizontal ones. Two tests will provide positive identification. The entire head of the muskellunge is scaled, but on the pike, only the upper half of the gills has scales. If one looks under the jaws of both fish, there are tiny holes called mandibular pores. The pike has five on each side, while the musky has six to nine.

Catfish (Ictaluridae)

Catfish have smooth skin with eight barbels or whiskers around their mouths. The barbels are taste buds. All of the fins on catfish are soft, but there are sharp spines on the dorsal and pectoral fins connected to poison sacs. If these puncture an angler's skin, they cause a painful wound.

Bullheads have rounded tails, while catfish have forked tails. Only the flathead catfish has a relatively square tail without the fork, but it also has a large, free-moving adipose fin between the dorsal and the tail. Coloration varies with the species, but catfish and bullheads are easily recognizable.

Suckers Catostomidae

Suckers have inferior mouths, soft fins, and the distance from the snout to the anal fin is more that 2 1/2 times the distance from the anal fin to the tail. There are several species, each with its own coloration, but the white sucker is the most common.

Saltwater Fish

Marine species are first characterized by their skeletal structure into cartilaginous or bony fishes. Sharks, rays, and skates use cartilage as the basis for skeletal support, while most other species fall under the category of bony fishes.

Several of the bony fishes are relatively easy to identify simply by looking at them. No other species resembles the bluefish which is a bluish-green above and silvery on the belly. It has a pointed snout, canine teeth that are very sharp, and a broad, forked tail. The first dorsal is over the pectoral fins and the second dorsal is twice as long as the first.

Bonefish, tarpon, and ladyfish are very distinct in their appearance. All three are silvery sided, shading to a darker hue on their backs, and have forked tails. The bonefish has dark streaks from the back to the lateral line and a long snout with an inferior mouth. Tarpon boast the largest scales of any fish and have a superior mouth with the lower mandible extending beyond the upper. The elongated, last ray on the dorsal fin is a positive ID. Ladyfish have a single dorsal fin in the middle of their backs and the pectoral fins are low on the body.

Sharks, Rays, and Skates

There are over 300 species of shark. Some, such as the great hammerhead or the blue shark, are relatively easy to recognize and identify. Others require considerable experience. However, sharks and rays are seldom mistaken for any other type of fish. The problem occurs in determining the precise species of shark. One may be able to point out differences in photographs of various species, but on the water, identification is more difficult.

Skates and rays are flat and have cartilagenous skeletons. There are a number of species of both. Skates do not have a poisonous barb near the base of the tail or on it; rays do. A tendency exists to lump all rays together under that common name, but each species has its own name.

Billfish

Billfish is the generic name given to a group of large game fishes that prowl the warm and temperate seas. They all have long, pointed upper jaws that form a "spear" or "sword" and include the marlins, sailfish, swordfish, and spearfish.

If one ignores coloration and deals with the fins, billfish are relatively simple to tell apart. The sailfish has a massive dorsal fin that is taller than the deepest part of the body. Blue, striped, and black marlin have pointed dorsal fins, but there are other differences. The pectoral fins on the black marlin are rigid and do not fold back as they do on the blue and striped. The pointed front of the dorsal on the striped marlin is higher than that on the blue, but the blue has a much higher anal fin than the striped. White marlin have rounded dorsal fins and the swordfish has a very long, wide bill, plus a high, curved dorsal fin.

Flounder

Flounders form a group of salt water flatfishes that live on the sandy or muddy bottoms of bays and along the shores of most seas. They ambush their prey by hiding on the bottom. For camouflage, they have a dark, mottled coloration on one side and white on the other. These fish even swim on their sides. Some have both eyes on the left side, while others have them on the right. Recognizing members of the flounder families doesn't take much skill, but there are several species among both the lefteyed and righteyed flounders. Those families are named for the side of the head on which the eyes appear.

Sea Bass

Sea basses are bottom dwellers that orient to some form of habitat such as rocks, reefs, wrecks, and other structure in water depths ranging from a few feet to over 1,000 feet. Groupers are part of this family and identifying the various species can prove somewhat tricky without practice. All of these fish are similar in shape to the largemouth bass in fresh water. The spiny rayed first dorsal is connected to the soft rayed second dorsal. Tails are square or round rather than forked.

Other Species

Oceans and estuaries contain many families of fish. Snappers, jacks, tunas, and mackerel, along with many bottom dwellers, require experience on the part of the angler before identification of the specific species becomes routine. One might recognize the family, but the particular species takes more time. The drums, including red drum, black drum, spotted seatrout, common weakfish, corvina, spot, croakers, and others offer enough differences so that they can be learned rather quickly. Cod family members, including the Atlantic cod, tomcod, hake, pollack, haddock, and others, are also rather distinct and easy to recognize.

The key lies in learning those species first that are more common and abundant in local bays and coastal waters and then adding to that knowledge as fishing trips take one farther afield.

Anadromous Fish

By definition, anadromous fish move from salt water and ascend fresh water rivers to spawn. Striped bass, shad, Pacific salmon, and some sturgeon fall in this category. Some species of trout and char such as the rainbow, brown, Dolly Varden, brook, and cutthroats move from streams and rivers into the ocean or big lakes for periods of time where they grow at a much faster rate. These are known as sea run or lake run fish. In appearance, a fish fresh from the sea often exhibits a much more silvery coloration than one that has remained in fresh water.

Basic Fish Anatomy—External

Form/Morphology

The shape of a fish's body is a visual clue to the life style of that species. Natural selection has tailored each species to a form that enables it to survive and reproduce. A trout that spends most of its life in river's moving waters is more streamlined than a largemouth bass, which lives by relating to structure in a pond or lake without water flow. Contrast that to the northern pike or the chain pickerel. Their shapes are tailored to ambush their prey with a swift, straight lunge.

A closer inspection reveals that the trout's body is sleek and torpedo shaped so that flowing water will pass around it with a minimum of friction. Bass have broad, flat tails and a chunkier body, which makes them highly maneuverable. They are adapted to swim around stumps and between the stalks of lily pads to take advantage of whatever cover they can find. The slender body of the pike with fins set well back near the tail and a mottled coloration spells ambush. Pike can get an amazingly quick start and launch themselves through the water with incredible speed over a short distance.

The most efficient design for speed through the water is the fusiform shape in which the greatest body girth is about one-third of the distance from snout to tail. Tunas are the prime example of this. Everything in nature is a tradeoff. The faster a fish can swim through the water, the less maneuverability it has.

Flat fish such as rays and flounders live on the bottom. Catfish have a shape and coloration that indicates they will probe the bottom for food. Bluegills and other members of the sunfish family are compressed, indication that they can work in tight places. They do not have great speed but boast the ability to maneuver well.

Fins

A fish's dorsal fin extends vertically from the back, usually starting rearward of the gill cover or operculum. Some are spiny rayed, meaning that they have hard, bony projections separated by membrane. Others are softrayed, in which the supports are supple and not hard. Fish may have one, two, or three dorsal fins. They could be a combination of spiny and soft and they may or may not be connected. Behind the dorsal, salmonids, catfish, and a few others have a small fin called the adipose.

The dorsal fin, along with the anal or ventral fin located just behind the anus, aids fish in maintaining balance and, in some species, help them manuever in tight places. Pectoral fins (one on each side) are positioned right behind the gill covers and are a modification of arms. They are used for staying in one place and for fine tuning a fish's position. On fast moving species, pectoral fins serve as bow planes, helping the fish to dive or surface.

Pelvic fins correspond to animal legs and sometimes have special functions such as holding, grasping, or even crawling. On most fish, they aid in positioning and balance. Species that move with extremely fast speed often are able to pull the pectoral and pelvic fins tightly against the body or into shallow recesses. It is important to note that all species do not have all fins, but most sport and game fish do have dorsal, ventral, pectoral, pelvic, and caudal fins.

The caudal fin, or tail, tells a great deal about the speed and maneuverability of a fish. Any species with a forked tail is a fast swimmer. Forked tails are hard on the outer edges like a skindiver's flipper and soft and flexible on the inside. Broad, flat tails indicate the ability to turn quickly and to start swimming instantly. Bass fall into this category. The trout's tail is one-sixth of its body length and wider at the end than at the base. One beat of a trout's tail pushes it about half a body length forward.

Scales

A fish's body is covered with scales (in most species) that serve as protective plating to prevent abrasions or skin diseases. The number of scales on a given fish remains constant and does not change as the animal gets larger. Like the cross-section of a tree trunk, scales show rings for growth and are a tool for scientists trying to determine the age of a fish.

Scales are really modified skin cells and take various shapes. Those on sharks are actually tiny teeth called denticles and are extremely abrasive. The tarpon has massive scales, often much larger than a silver dollar. Some of the fastest swimming fishes, such as the tunas, trouts, salmons, mackerels, and others, have very tiny scales.

Slime

Slime coats the body of a fish, serving as protection against disease, fungi, and parasites. It also aids in reducing friction and may have benefit in reducing the transfer of water through the body wall. In handling a fish prior to its release, extreme care must be taken to minimize the damage to this slime.

Coloration

Coloration in fish serves a variety of purposes from concealment and camouflage to recognition by schoolmates. Every hue imaginable appears in one species or another and some have the ability to change color. When fish get excited, a color change often occurs with portions of the shading becoming much more vivid and neon in appearance. Taxidermists frequently paint dark black markings on the side of a largemouth bass. When it is caught, the coloration becomes much more vivid than normal because the fish was stressed.

Almost every species is countershaded or dark across the back and light on the belly. It is an effective form of camouflage that makes a fish look flat, eliminates dimension, and compensates for light coming from all directions. When a predator looks down on the dark back, the fish is difficult to detect. Viewed from below, the light belly blends with sky and clouds.

Fish are marked in a variety of ways to complement their life styles. Bottom dwellers are usually mottled, while pelagic species are silvery or relatively light along the flanks. Species that are all silver on the flanks reflect their surroundings and gain camouflage that way. The pattern of a northern pike resembles sunlight filtering through a weedbed. By definition, stripes on a fish run horizontally and bars and bands completely encircling the body are vertical.

It is important to realize that the reds are the first colors to disappear with depth or horizontal distance in water. Red colors may look bright to the angler on the surface, but quickly fade underwater. Blues and greens retain their color to the greatest depth and distance.

Bright colors on a fish are vital in schooling behavior, for spawning, and also in establishing territories. Other members of the same family can see the colors of a fish in residence and keep out.

Skeleton

Most fish have a bony skeleton with the various body parts held together and to the skeleton by connective tissue. Sharks, of course, have a cartilagenous skeleton. These are extremely complex structures. The organs of sense along with the brain are held in the skull. Since fish are vertebrates, there is a backbone running the length of the animal. The position and structure of the spine aids some species in swimming, offering the flexibility necessary to undulate from side to side. Bones attached to this serve as ribs. The skeletal form determines the shape of the fish, protects the vital organs, and serves as support for the muscles.

Gills

A fish's cells, as with all animals, require a continuous supply of oxygen. The exact amount depends on water temperature, level of metabolic activity, and the particular species. The gleaning of oxygen and release of the by-product carbon dioxide occurs through the gills. Bony fishes have four pairs of gills, while sharks may have as many as seven. Fine, red filaments in the gills aid in the interchange.

Water enters through the mouth, which then closes. The operculum or gill cover opens slightly and water passes through, moving over the filaments. In moving water or when a fish swims, the flow occurs without aid. With a stationary fish or when there is no water flow, the flow of water is created by opening and closing the mouth.

Soluable pollutants can affect fish as water is passed through the gills. Fish absorb toxins through the gills as well as through the food chain. Also, sediment can serve as an irritation, causing inflammation or actually clogging gills, and making it difficult for the fish to receive adequate oxygen.

Gas Bladder

If it weren't for the gas or swim bladder, many species of fish would have difficulty hovering in the water because they are heavier than water and would sink. In most fish, the gas bladder is an air-tight sac (closed system) much like the human lung. Fish can inflate or deflate it at will. Some primitive fish have an open system with a tube leading into the esophogus, allowing them to gulp air. Position of the swim bladder is vital and it is usually found near the fish's center of gravity. If the bladder were too far forward, the fish would tip upward.

Swim bladders are larger in freshwater species, occupying 7 to 11 percent of body volume. Because salt water is more buoyant than freshwater, saltwater species have a bladder occupying 4 to 6 percent of body volume.

Some species do not have gas bladders or do not rely on them. Tunas, sharks, mackerels, and others remain in motion to force water across the gills and do not need a bladder. If a fish were to rise too rapidly, the bladder would expand and the fish could not get back down until the air was eliminated and the bladder reduced in size.

How Fish Swim

Most fish swim by undulating their bodies in a snakelike motion and snapping their tails. Forward thrust comes from the backward push of the muscle wave, culminating in the tail snap. Fish are almost solid muscle arranged in segments or flakes. These muscles are controlled separately so that a wave or rippling effect can be created. If a segment on the right is in full expansion, the opposing muscle on the left side is in contraction. Thinner and longer fish use more of the wave action to swim. Species such as the bass also depend on their broad tails to propel them. Members of the tuna family generate incredible speed by beating the tail as much as 10 to 20 times per *second*. A single tail beat drives the tuna about a body length.

In general, the larger the fish, the faster it can swim. There are variations among species, but one can estimate that the top speed of a fish is about 7 miles per hour per foot of length. Swimming speeds are also calculated as sustained and burst. Burst speed covers a sprint over a very short distance. When fish of the same size school together, their swimming efficiency is enhanced. Larger fish swim faster and smaller ones have to exert more energy to keep up with the school.

As a fish swims, water passes through the mouth, over the gills, and out behind the gill covers. This water moves along the body of the fish, reducing turbulence and creating a laminar (smooth) flow that lessens the drag. Research has shown that most species open the gill covers to achieve maximum laminar flow. Some species even excrete a special slime that reduces body friction when swimming. A few species rely on their fins for propulsion, but that is not a very effective method. These are bottom, reef or weed bed dwellers that work in and out of cover. Most fish use their fins for positioning and for very gentle movement, but it is the muscular undulations followed by tail snaps that constitute the swimming action.

LESSON 19

Fish Behavior

LESSON 19

Fish Behavior

Lesson Objectives

Following this lesson students will:

1. Understand why fish act and behave the way they do.
2. Be able to discuss the reaction of different species to food, comfort zones, reproduction, predator/prey relationships, and seasons.
3. Understand the influence of biological necessities such as spawning, seasonal migrations, food consumption, and seasonal adjustments.
4. Be able to discuss how an angler can benefit from this knowledge.

Materials for the Lesson

1. Overhead transparencies and photocopies of graphics in the appendix.

TEACHING STRATEGY

Lesson Content Outline

I. Reasons for Behavior
  A. Evolution
  B. Anatomy
  C. Habitat
    1. Structure
    2. Thermocline
  D. Senses

II. Types of Behavior
  A. Food
    1. Location
    2. Protection
  B. Comfort
    1. Oxygen
    2. Temperature
  C. Reproduction
  D. Predator/Prey
  E. Seasons

III. Learning about Fish
  A. Migration
  B. Food Consumption
  C. Spawning
  D. Adjusting to seasons

Classroom Procedure

1. Introduce class to the lesson objectives.
2. Begin the class by discussing factors which affect fish behavior:
   A. Water Temperature
   B. Anatomy
   C. Spawning
   D. Food preferences
   E. Predator/prey position
   F. Seasons
   G. Structure
   H. Oxygen
   I. pH levels
3. Select graphics for several locally popular species of fish. Discuss each of the above factors for each species that you choose. The text has much information that will be of assistance.
4. Use graphics to show where fish can be expected to be found during different seasons of the year and how the food chain affects them.
5. Throughout the class discussion, relate these factors to angling success.

INTRODUCTION

Understanding fish behavior is both important and interesting. By understanding fish behavior, one gains a greater appreciation of fish and their delicate place and important role in nature and in the total biology of waterways. Anglers gain an insight into how and why fish react, where they most likely live, and why each species has different food requirements and prefers different habitat. This understanding translates into knowing where and how to fish, what lures to use, locations of fish at different times of the year, predator/prey relationships, and the role of senses in catching fish.

NARRATIVE

Reasons for Behavior

Behavior is nothing more than the way an animal reacts and the causes of that reaction. All animals exhibit behavior unique to their species and environment, and fish are no different than other animals. Basic to this behavior is the role of evolution. This reaction to the environment affects the selection of water temperature sought by fish, their oxygen requirements, basic anatomy, spawning methods, food sought and eaten, position in predator/prey food chain structure, and seasonal movements and migrations.

Evolution could be considered responsible for the presence of a large oil globule in the eggs of Chesapeake Bay striped bass in comparison to the smaller oil globule in Hudson River striped bass, both of the same species. The larger oil globule floats the eggs better in the slow moving tidal rivers of the Chesapeake Bay, preventing the eggs from sinking and dying before hatching out. This is not important in the faster waters of the Hudson.

The basic anatomy of the fish controls what it does, how it moves, and what it eats. The long body of pike, pickerel and barracuda makes them extremely effective in tracking prey (or lures) but less able to turn rapidly (as would a trout, bass, sunfish, or catfish) to take a lure or to grab a baitfish.

Anatomy also controls the speed of the fish. Trout and salmon are known as fast swimmers since their body muscles control wide tails. The same applies to the football-shaped tuna and albacore. Carp, sea bass, and largemouth bass are not swift swimmers. The shape and position of the mouth in sturgeon, bonefish, carp, suckers and cod make them ideal bottom feeders, while the teeth of pike, bluefish, barracuda, walleye, and sea trout make them ideal for catching and holding slippery, fast-moving baitfish. As a result, bottom feeders are often constantly moving, while some predators such as largemouth bass will lurk by structure and wait to ambush passing food.

Structure in habitat is also important, although some fish do not relate to structure and constantly swim, searching for food and working to maintain favorable oxygen, temperature, light intensity, current and comfort zones. Many ocean fish, such as wahoo, billfish, shark, bluefish, tuna, dolphin and salmon, are free swimmers.Some inshore saltwater species, such as sea bass, tautog, sea trout, and others, stay near structure areas, e.g., sand bars, rocky bottoms, and oyster bars.

Many freshwater species, including small and largemouth bass, stream trout, panfish, walleye, pike and musky hold by a given structure or cover in the water and cannot survive well in waters lacking this required structure. Some fish such as Great Lakes salmon, lake trout, and many open ocean species follow oxygen or temperature levels as they search for food.

Senses are far more acute in some fish than in others. These are significant in their feeding behavior. Eels and salmon are noted for their ability to smell. Bonefish and sturgeon feed by taste and catfish have taste buds all over their bodies so that they can taste a food before even taking it into their mouths. Sight and sound feeders include bass, billfish, barracuda, shark (though they also feed by smell), trout, striped bass, shad and steelhead.

Types of Behavior

Food, water temperature, oxygen, ph, current, reproduction, predator/prey relationship and seasons all affect what fish do, how they do it, where they do it, and when.

Fish must have food on a regular basis. While each species varies in its food requirements, the presence and ready availability of food is mandatory for preservation of a species. Some fish hide and wait for food. Others actively and constantly hunt forage fish. Some constantly search the bottom for food, almost like grazing cattle. Ideal food situations for different fish species can include everything from the presence of large schools of bait fish, to a fertile bottom, to structure that will hold and allow for reproduction of a basic food chain, some of which will be food for the fish.

Oxygen requirements are critical but will vary with the species. Carp, bullheads, and some minnows require relatively small amounts of oxygen in the water, while trout and salmon require a lot. Thus, trout can be found in highly oxygenated, free flowing streams, but will not be found in depleted habitat where carp thrive. Trout thrive best in water containing up to 10 parts per million of oxygen while carp can survive on as little as 2 or 3 parts per million of oxygen.

Temperature is also important. "Cold water species," including the trout and salmon, require colder water than "warm water species," such as bass and panfish. These warmer temperatures would kill any of the trout species. Even different species of the same families differ. Brook trout (actually a char) require the cleanest and possibly the coldest water of the popular stocked trout species. Brown trout may be able to withstand warmer temperatures and more silting and are more suited to slower rivers or late spring and summer stocking.

All fish, as a result of their cold-blooded nature, become more sluggish in colder water and require less oxygen and food. Their metabolism slows considerably, thus reducing their needs.

Fish have pH (hydrogen ion content) requirements, but most fish can tolerate a range of 3–4 pH units. This is of great importance today because of the great concern about acid rain and the adverse effect that this has had on our lakes and streams, primarily in the North Central, North East and Canada. pH is a balance of hydrogen ion content of the liquid (water in this case) with a pH of 7.0 being neutral. pH numbers range from a low of 0.0 (acidic) to a high of 14.0 (akaline). Larger numbers are alkaline (high pH) while smaller numbers (less than 7.0) are low pH and acidic. The lower the number the more acidic.

The numbers are based on a logarithmic or geometric ratio, not an arithmetic one. Thus, a change in the pH of one point (1.0) can markedly change the acidity and significantly affect fish behavior and comfort. High acidic (below pH 5) or alkaline (above pH 9) waters can markedly reduce fish populations, kill fish, prevent reproduction, destroy eggs and fry, and make any fishing or enjoyment of a waterway impossible.

Current may or may not affect fish. Fish that require current, such as trout, smallmouth bass, and salmon do not generally do well in waters with no current. However, when young fry or fingerlings of a species are present, too fast a current (as during a spring flood, hard rain, water released from a dam) will wash them downstream and destroy that season's production.

Fish react in different ways to current. Some fish hide or rest by a rock or other structure to stay in the buffer zone that surrounds all obstructions. Other fish will actively seek a current and follow it for the information (smell, taste, temperature) that it provides. In all cases, fish will head into a current. To do otherwise would wash water backward through their gills, which would make them uncomfortable or kill them. This is why in eddies or currents, in which the current turns back upstream, fish will be facing downstream but headed into the eddie current.

Reproduction plays a very large role in the behavior of fish. It is the reason for largemouth bass coming into the shallows in the spring to make beds for laying eggs. It is also the reason that eels make long runs down rivers to spawn in the Sargasso Sea (catadromous) while salmon and shad make long runs from the ocean to the headwaters of free-flowing, fast current rivers to lay eggs in the same waters where they were hatched (anadromous). Some species, such as striped bass and yellow perch, make similar short runs up tidal or tributary streams to spawn.

All fish have a role in the complex predator/prey relationship. Usually the prey species are small, very numerous, and travel in schools. Prey species are somewhere in the middle of the food chain, eating smaller organisms such as insects, smaller fish, invertebrates, and crustaceans, while providing food for those fish at the top of the food chain, primarily the "game fish" or sport species.

In a general sense, fish reaction depends upon whether they are predator or prey. Small prey species move and react as hunted species. Large predator fish at the top of the food chain have less to fear from most other fish species. As a result, they are calmer, less "nervous" in the water, and move more slowly, except when actively chasing prey, attacking a food species or feeding on schooled baitfish.

Seasonal patterns determine the water depth sought, food intake, migration patterns, spawning, coastal movements, schooling and general activity of fish. Seasonal changes are accompanied by changes in water temperature, the amount of light, and hours of daylight. Summer months have more light and longer hours of sunlight than winter periods due to the higher angle of the sun.

Lower temperatures result in less fish activity, often semihibernation at deeper depths, schooling with some species, and reduced food intake. Warming temperatures and a higher sun angle in the spring usually trigger spawning behavior, voracious feeding and a return to shallower waters. Seasonal patterns are a continuous cycle in which a given species can be counted on to perform similarly during the same season year after year.

Fishermen use this information, even if they are not always aware of it. Shad runs along the East and West Coasts are examples of using seasonal patterns and information to catch these fish. Summertime bass hold on breaklines near shallow water or near wood structure, while lake trout and salmon species follow the sharp temperature gradient—called a thermocline—during the same months.

Learning about Fish Behavior

Good fishermen must learn about fish migration. Migrations vary with each species and most fish have some migration or movement on a daily basis. These include movements from shallow to deep or deep to shallow water, movements into feeding areas, and movement varying with light intensity or water temperature. During the warmer months, many species frequent the shallows to search for food. Often as light intensity increases, they move out of the unprotected shallows (where they could become prey for birds of prey or shoreline animals) and migrate to protected deeper waters. Even if not searching for food in the shallows, many species are sensitive to light and move to deeper waters. Migrations also include horizontal movement, movement from a shallow cove out into a channel or breakline in deeper water.

Salt water species are also subject to daily movements based on tides and currents resulting from tidal flows. These movements are not based on sunlight intensity or a temperature gradient (although these can also be factors), but on the flow of the water with the resulting current and the movement of their prey.

These daily up and down movements, small migration routes based on tidal flow or food supply, are found in some degree with all species. Seasonal migrations are also caused by broad changes in food availability, temperature, current changes, light intensity and spawning urges. Seasonally, fish make major changes in their behavior. Winter often finds cold blooded fish dormant or semidormant, schooled together seeking the warmer deeper holes. Offshore salt water species usually go south, following specific coastal currents such as the Gulf Stream or the Japanese Current.

Spring finds most species spawning and moving to waters or areas where spawning is possible. It is also a time when fish become active feeders since they require more food as their metabolism rises with the rising temperatures.

Summer is a time for adult fish to recover from the rigors of spawning (which for some species can be extremely strenuous) and to follow regularly established feeding patterns, often with shallow and deep daily migration patterns due to the changing light intensity. As fall approaches, many species feed more actively and begin to return to the shallows.

Food consumption varies with the size of the fish, species of fish, food habits of the fish and season of the year. Food consumption definitely affects the behavior of any fish species since adequate food is paramount to continued life. Just how and what a fish eats will affect its movement, schooling habits, and presence at different water depths.

Some fish feed by constantly searching the bottom (suckers and catfish), some actively feed from the surface (bass and trout), and others only eat at the middepths. Some will pick up any type of dead bait (bluefish) while others insist on live bait or a lure that resembles live bait (billfish and barracuda).

Spawning is an ideal time to catch fish, although with some species it is also a controversial time. Some anglers and biologists feel that too many fish can be taken too easily during this period, which could contribute to the long term detriment of population stocks.

This depends greatly upon the species. Some species such as the Pacific Coast salmon die after spawning so that catching these fish during their spawning period or immediately after will not affect the long term survival of the species. Salmon have also been stocked in the Midwest and Great Lakes area where similar considerations apply. Atlantic salmon and shad are popular East Coast fish that make long spawning runs and do not die after spawning.

Spawning methods vary greatly and occur from established beds (bass and panfish) to less defined redds in streams (trout and salmon). Yellow perch spawn on brush, plants, or bottom structures while striped bass, bluefish, and ocean species are free spawning. The eggs are fertilized and distributed to the open waters.

Different seasons find fish in different places and exhibiting different behavior. Anglers must adjust to these variations to catch fish consistently. This takes knowledge of the fish and an understanding of the way they act and react. Food preferences, water types, spawning patterns, thermal requirements, structure needs, salinity limits, and other environmental preferences must be understood for each species of fish sought.

LESSON 20

Fish Reproduction and Growth

LESSON
20

Fish Reproduction and Growth

Lesson Objectives

Following this lesson students will:

1. Understand how spawning affects a fish's behavior and governs movements and migrations.
2. Be able to identify changes in behavior as well as physical differences and follow the spawning cycle.
3. Know the importance of spawning cycles and seasons as they relate to fishing.
4. Comprehend basic relationships between predator and prey.
5. Understand the relationship between age and growth.
6. Identify the factors affecting fish growth.
7. Learn why each species has its own foods and how this food helps to determine growth.
8. Know the feeding habits of various species and how these habits relate to fishing.

Materials for the Lesson

1. Overhead transparencies and photocopies of appropriate graphics from the appendix.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
	Due to the content of this lesson you may want to invite a fisheries biologist to participate and discuss many of the scientific aspects of this subject. He/she may also be able to bring a film or filmstrips to illustrate much of the content.
I. Reproduction A. Spawning Cycles as Behavior Regulators B. Breeding 1. Behavior 2. Care of the Young C. Sexual Differences 1. Coloration 2. Size 3. Morphological changes	1. Introduce students to the lesson objectives. 2. Begin by emphasizing that the biological urge to spawn overrides other behavior patterns. Discuss the spawning of several locally popular fish. Indicate the type of conditions needed by these fish, that they all, even ones of the same species, do not spawn at exactly the same time, and the habitat they prefer for spawning. 3. Discuss the spawning behavior of fish that may not be favorites in your area. Salmon, trout, and striped bass move up rivers or streams to spawn. Other fish do not spawn every year and the number of eggs depositied varies greatly with the species. 4. Discuss how the eggs are fertilized, hatched, and protected (at least by some species).
II. Foods, Digestion, Nutrition and Growth A. Fish and the Food Network 1. Predator/prey 2. Food Preferences B. Food Conversion	5. Discuss the predator/prey relationship and its affect on growth. Predators will prey on almost anything smaller, including its own species. Lack of baitfish or an oversupply of predators can limit or stunt growth and lead to a smaller number of larger fish to catch. 6. Fish convert food to energy slowly and this varies with many factors. With cold water, fish require less food and it is digested more slowly. Fish seem to prefer certain foods if they are available, such as crayfish in freshwater and shrimp in saltwater.
C. Fish Growth 1. Factors a. environmental b. water quality c. age	7. Discuss fish growth and the factors that influence growth including: A. The abundance of food B. Water temperature C. The type of habitat or body of water D. Carrying capacity—each body of water can adequately support only a certain number of fish E. The amount of space required by certain species, e.g. musky F. Water turbidity and its effect on spawning and photosynthesis 8. Discuss growth rates since fish initially grow quite rapidly while young, but much more slowly when older.

Lesson Content Outline	Classroom Procedure
D. Fish Feeding Habits	9. Ask students what they know about the feeding habits of locally popular fish. Indicate that many species of fish feed close to where they were born, while other roam great distances, following migrations of baitfish and temperature gradients in larger bodies of water. 10. Discuss the methods that locally popular species utilize to feed. Discuss the shape of the fish's body and how this affects their feeding behavior. Discuss how these methods can vary from still to flowing waters. 11. Ask students how the information presented relates to fishing success. Angling success can be greatly increased through understanding the concepts presented in this lesson.

INTRODUCTION

To the angler, spawning is more than a process for reproducing the species. Usually, there is a movement or migration associated with spawning as well as changes in behavior. What a fish actually does can be broken down into pre-spawn, spawning, and post-spawn periods. Knowing what happens at what time becomes critical in catching fish. Spawning is a complex biological process that takes precedence over the fishes' other biological processes. For some species, reproduction signals a modification in coloration or morphological changes. Some fish spawn each year after reaching maturity, while others only spawn once and then die. The time to attain maturity varies among species and individual fish.

To survive and eventually spawn, a fish must feed and grow. Its diet and habitat play a critical part in its growth and how quickly it converts food to energy and weight. Basic factors govern feeding and dealing with predator/prey relationships. Researchers have developed general guidelines on how fish feed and their food preferences. Those that feed most successfully survive to maturity and spawn.

NARRATIVE

Reproduction

Spawning Cycles as Behavior Regulators, Fish Movements

The biological urge to spawn totally overrides other more typical behavior patterns. Reproduction is vital to the continued survival of each species and must be accomplished successfully by each generation. Reproduction generally follows three basic methods. In most instances, the female deposits eggs in the water which are immediately fertilized by sperm from the male. It is not unusual for more than one male to fertilize the eggs of a single female.

Another method involves fertilizing the eggs within the female's body before they are deposited in the water. In the third situation, the female retains the eggs within her body and the young are born alive. Certain sharks and rays fall into this category along with guppies, mosquitofish, sun perch, and others.

A fish must become sexually mature in order to spawn. Age at maturity varies with the species. The shorter time a species lives, the sooner a member reaches sexual maturity. Species such as trout and bass tend to spawn every year once they reach maturity. However, salmon require two to five years before they spawn, and then most species die. Some eel may only spawn every 10 to 12 years. Researchers understand how the external factors of temperature, water quality and the diurnal period (amount of light) trigger the spawn, but definitive work on the internal mechanism has not been conclusive. Suffice it to say that nature makes certain that the urge to spawn and the development of eggs or sperm take place at the correct time.

It is important to recognize that even when spawning conditions are ideal, all fish of a given species do not reproduce at one time. Usually the spawn is spread over a period of time. If all the fish in a lake deposited eggs on the same day, a condition such as the water temperature suddenly dropping, would destroy all of the eggs. Some species do not drop all of their eggs at one time, spreading the actual spawn over several days and locations. This spacing also assists in the percentage of eggs hatching.

Each species favors a certain habitat for spawning and subscribes to a particular pattern. During the pre-spawn period, a fish begins to change its behavior pattern and moves into position for the actual spawn. This movement may be small, such as when bass or bluegill pick a site for a bed.

Stream trout may leave their preferred feeding territory and work their way to the headwaters or up a tributary to spawn. The salmon epitomizes the spawning urge by ascending the river until it reaches the stream near the spot where it was born. This is accomplished through its sense of smell. As a juvenile, it received a chemical imprint of the water where it grew and the salmon uses that data to return. Spawning salmon work their way over small waterfalls, up well-designed fish ladders, and around most obstacles until they arrive at their ultimate destination.

Striped bass also come in from the sea, but their goal is to find brackish water of the right salinity to hold their free-floating eggs in suspension until they hatch. The eggs must be deposited in a location where the flow of the river is such that the larvae hatch in water of the correct salinity.

The American eel spawns in the Sargasso Sea off Bermuda. It leaves coastal rivers and makes its way to that ocean location where reproduction occurs. Then the young eels must find their way back to the rivers to survive and to live until it is their turn to spawn.

Fish that are ready to spawn are heavier because of the roe (eggs) or milt (sperm). The eggs in a female may account for as much as 25 percent or more of her body weight, while the milt in the male could account for 12 percent of its body weight.

From an angling standpoint, knowing the time of year that various species spawn and where they go is a vital factor in successful fishing. One might raise the question as to whether it makes sense to attempt to catch spawning fish or if it is better to allow them to reproduce before trying to land them. Some species such as the salmon do not feed during the spawning period, although fish can be tempted into striking a bait or artificial lure either out of habit or in an attempt to drive it away.

Breeding

Breeding takes place in several ways, depending on the species. Some species congregate in huge schools when it is time to spawn. Others gather in smaller groups. A female may spawn with several males. When this occurs it is likely that the eggs are fertilized once they are deposited. Tarpon have a ritual of forming a circle called a daisy chain and swimming around and around. Certain species pair off, frequently building a nest to hold the eggs.

The female salmon digs a nest or redd with her powerful tail while the male protects the territory and drives off others. Then the female settles over the redd and the male swims over her, touching her dorsal fin or nudging her with his snout. When it is time to spawn, he curves his body around hers. As she begins to drop the eggs, he promptly fertilizes them.

A largemouth bass builds a nest close to shore where the young will have some form of cover. Spawning takes place in the spring and seems to be triggered by water temperature ranging from 60 to 70 degrees F. Bluegills spawn slightly later, preferring a water temperature of about 70 degrees F. Like the bass, the bluegill builds a nest in the shallows. Crappie also spawn in shallow water, but they build their nest close to vegetation and wait until late spring or early summer to reproduce. Brown and brook trout spawn in the fall of the year, but native rainbow and cutthroat reproduce in the early spring. Fish that lay eggs are said to be oviparous, while live bearers are called viviparous. Fish that build nests, which require greater parental care, usually deposit fewer eggs than those that broadcast their eggs at random. However, bass and sunfish may only release a few hundred eggs, while the average cod may drop 3 million eggs.

Once the eggs are deposited and fertilized, cell division begins and continues into the larval stage. The embryo receives nourishment from the egg's yolk sac. Larvae development is usually quite rapid, occurring in few hours to several days. Larvae can propel themselves to some extent, but usually rely on water movement. As the yolk sac is exhausted, the fish must feed on its own. They are then considered juvenile until reaching sexual maturity.

The Tilapia carries its eggs in its mouth until they hatch. This helps to eliminate predation at the earliest stage. Bass and other members of the sunfish family build nests. The fertilized eggs drop to the bottom in the nest and adhere, with the male bass fanning the eggs constantly while it stands guard to keep silt from settling. The bass will not feed while guarding the nest, but it will use its mouth to move anything away from the eggs and the fry. That is why they strike lures at this time.

Eventually the young fry are abandoned by the male and left to fend for themselves. Crappie follow a similar nest-guarding procedure, but they are the first to feed on their own offspring. A single female crappie may deposit 150,000 eggs in the nest; however, most of the juveniles are devoured by the parents.

The colder the water, the longer it takes for eggs to hatch. Trout and salmon deposit their eggs over gravel bars where there is a good flow of water to prevent silt from covering them. It often takes two to three months or longer for a trout egg to hatch. All of them do not hatch at the same time, but the young fry as well as the eggs are very vulnerable to predation.

Those species that broadcast their eggs in open water offer no parental protection or care of the young. They simply deposit the eggs, which have to be fertilized at once, and let nature take its course. Of the millions of eggs released, enough survive to repeat the cycle for another generation.

Sexual Differences—Dimorphism

In most species of fish, the only way to tell male from female is to examine the gonads. They appear the same and there is no way to identify the sexes by merely looking at the fish. However, there are exceptions. The male or bull dolphin has a blunt forehead, while the female has a rounded head. Males of certain catfish species have longer barbels than the females, and in some of the flounders, the male will have a longer dorsal or pectoral fin.

During spawning or just prior to it, changes occur in some species. Larger trout and salmon commonly develop a hook or kype on the lower jaw and sometimes on the upper. At this time, the male salmon may develop a rather weird looking dorsal hump. The males of a few minnow and sucker species become covered with horny breeding tubercles that help them drive away other males.

Except at spawning time, coloration among males and females is much the same. Individual fish may show darker or lighter shades, depending on their habitat, but there is little difference between the sexes, except near spawning time. Prior to the spawn, male trout and salmon show more intense coloration than the females. Darters also become highly colored in other species as well. Coloration is one way that a fish can recognize a mate; hence, why it may become more brilliant during spawning.

In many species, the female grows much larger than the male. This is certainly true for largemouth bass, striped bass, and even marlin and tarpon. Usually when one catches an exceptionally large fish, it is a female. The reverse is true for dolphin. Males grow larger than females. With the few exceptions noted above, there is no way to tell a male from a female without internal examination. It is not uncommon to see small, mature males spawning with oversized females.

When the salmon returns from the sea to spawn, it is a firm, powerful fish with silver coloration and a darker back. Once it enters the river, it no longer feeds (at least not on a regular basis), living off the fat and protein it has stored. The fish's goal is to reach the spot of its birth, spawn, and then die. Some Atlantic salmon do survive and return to the sea, but the Pacific salmon do not. Their color begins to change and they become much darker, losing the silvery tones of the sea. Just prior to the spawn, colors become extremely intense. The arduous journey has sapped these fish of their strength and their once firm bodies are in a state of deterioration.

With a final effort, the spawn is completed and the fish die within a few days. Their rotting carcasses provide food for a variety of birds and animals, but more important, they put nutrients back into the rivers. These nutrients support the aquatic life that sustain the fry and the juvenile salmon during the next year. It is an incredible story in which one generation dies so that the next can live. If these fish did not die, there would not be enough food in the streams and rivers to feed the young.

Importance of Spawning Cycles and Seasons

Several species of salmon may use the same river system to spawn, but not at the same time. There may be more than one run in a given year. This spaces the spawn so that each species has the area to itself and does not have to compete.

Nature is a complex phenomenon in which interdependence is often critical. A gamefish may spawn before a certain baitfish species that later is a mainstay in its diet. That way, the predator is slightly larger than its prey and able to ingest it. Without adequate food, the fry would not survive.

In salt water, spawning often takes place during a particular season that coincides with certain tides or currents. Flying fish spawn when the Sargassum weed is present. Their eggs resemble the tiny berry-like floats that support the weed. This adds camouflage for the eggs and gives the fry a place to hide and grow.

The popular blue fish spawns offshore, relying on favorable currents and eddys to carry the fry back into the estuary. The urge to spawn occurs at a time when these conditions are present.

When one considers that only a minute fraction of the eggs and subsequent fry ever make it to adulthood, the odds seem almost insurmountable. To maintain a stable fish population, each mature adult must at least replace itself. When additional fish are produced, populations rise. Anything less than one-for-one replacement results in population decline. However, the amount of fishing pressure directly affects fish populations, as do a number of environmental factors including pollution and physical destruction of habitats.

Foods, Digestion, Nutrition, and Growth

Fish and the Food Network

To be successful at feeding and growing, a fish must not only ingest food, but must also assimilate that food into its system efficiently. As food enters the bloodstream of a fish, it is first used to supply energy for immediate activities and internal functions. Anything left over from this task then goes to build muscle, bone, and tissue as part of the growth process. Some of the excess food can be stored for later use in the form of fat, but that occurs only after the first two requirements have been fulfilled.

Efficient feeding allows fish to expend a minimum amount of energy for the nutritional value received. If more energy is expended than gained on a long term basis, they become weakened and may become prey instead of predator. It could even starve, although that would take a long time. Fish must cover their energy needs for feeding, spawning, migration, defense, and body functions, turning the rest into growth.

Researchers report that most fish must consume a *daily* amount of food of average quality equal to about one percent of their body weight just to stay alive and active. That means that a 3-pound bass has to ingest about half an ounce of food every day. Therefore, this fish requires almost 11.5 pounds of food per year just to exist. Experienced anglers know that a bass will not chase a lure very far. It probably is not worth the expenditure of the necessary energy to chase the bait any distance.

A fish uses considerable energy when feeding heavily; therefore, frenzies are usually over quickly. A school of predators may attack baitfish, feed briefly, and then return to a normal swimming pace to rest. It is also important to recognize that fish frequently feed when the opportunity is there. They do not have to have three meals a day with snacks in between.

Within any body of water the relationship of predator to its prey is extremely complex. Most gamefish, for example, will devour almost any type of smaller fish, including its own kind. By doing so, the predator limits the numbers of its prey and controls that species. Usually, baitfish live shorter lives than gamefish and reproduce more quickly. If there isn't enough food for predators, they go elsewhere or their numbers drop, providing the prey a chance to recover. A shortage of food affects the growth of a predator and it often reduces the rate of reproduction. An abundance of food causes rapid growth and much greater reproduction. Everything is interrelated.

At times, a fish will specialize on one type of prey, ignoring others. As a general rule, fish tend to take the largest prey that they can swallow easily. That gives them a greater return for the effort expended. They also select and attack one victim at a time. Their strike is very specific and targeted at only one victim.

If prey becomes isolated, disabled, or looks different than the others, it will be singled out and attacked. When baitfish school, it presents a shimmering mass to a predator. It is difficult for the predator to isolate its prey when the school keeps changing position and course. Stragglers or those baitfish that stray from the school are easily picked off.

Food Conversion and Nutrition

Even under the best conditions, fish require at least twelve hours to digest and assimilate food. However, this varies with many factors. This chemical process depends on body temperature. Since fish are cold-blooded, the temperature of the water determines how fast food will be digested. How much a fish has in its stomach has little bearing on the time required for digestion.

A largemouth bass living in 72 degree water would require about 18 hours to digest the food in its stomach. That same task would take almost four days to accomplish during a northern winter. The colder the water, the less food a fish requires, therefore, needing to feed only every four or five days, or less, in cold weather.

Most species rely on a varied diet, but a predator may concentrate on a specific prey if that prey is in abundance. Fish seem to prefer the foods that give them the most energy.

In fresh water, the crayfish is a favorite food just as the shrimp is in salt water. Studies show that fish which feed primarily on crayfish grow much faster than those that prefer other prey. When crayfish are abundant, they become a favorite food and other prey become secondary. A body of water with a large crayfish population frequently produces more than its share of trophy fish.

During one study in Minnesota, bass were put in a pond with 1,000 crayfish and 1,000 bluegills. At the end of 20-days, the bass had eaten 24 crayfish for every bluegill. More importantly, those on a bluegill diet lost weight, while those that fed on crayfish gained weight. This could possibly be attributed to the expenditure of less energy feeding on crayfish.

In salt water, crabs, shrimp, and other crustacea seem to produce similar growth patterns. Perhaps it is easier for a gamefish to catch crustacea than baitfish darting around.

Water temperature is equally important for digestion in the marine environment. Experts think that swordfish come to the surface during the middle of the day to benefit from warmer temperatures and to aid digestion. At least some marine species appear to have a slightly faster digestive process than their fresh water counterparts.

The bottom line is that a fish's stomach can only hold so much food. It requires considerable time to digest that food, even when water temperatures are relatively optimal. Until the food is digested and assimilated, the fish probably is not ready to feed again. However, bass often strike on a full stomach.

Fish Growth

A number of factors determine how fast a fish will grow, including the abundance and availability of food as well as the temperature and condition of the water. Each species has a typical life span. Baitfish such as minnows may only live for a year, while a trout may live for six to eight years or more. The longer the average life of a fish, the more time it takes to grow and reach sexual maturity. There are numerous 100-pound tarpon, but it takes almost a dozen years to reach that size. A dolphin, on the other hand, may only live four or five years and reaches its maximum size and weight in that time.

Theoretically, a fish is capable of growth throughout its life, but the most substantial growth occurs in the early years, as in humans. A study of bluegills showed that two-year old fish were able to assimilate a little over one-third of the protein they ingested, but eight-year old bluegills could barely convert 20 percent of the protein. Also, younger fish often put three times as much food value to work in growth than an older fish. Body maintenance requires more with larger fish.

As a general rule, the colder the water, the longer it takes a fish to grow. That's because the growing season is so short. Trout and char in the extreme north require years and years to reach trophy size. Fish that live in warmer waters including those of the same species,grow much faster. For example, largemouth bass in the south usually grow larger faster than family members in northern lakes and ponds. Growth is very slow or non-existent during the winter and while spawning.

Since water temperature affects digestion and basic metabolism, fish living in colder water don't require as much food and take longer to assimilate it. Food and the energy expended to obtain and digest it are the keys to growth. One can forecast growth rates for any species in general terms by looking at the geographic area.

Environment plays a key role in growth. Fish in a body of water where food is plentiful grow larger in a shorter period of time. The same species in a neighboring waterway where food is scarce are stunted or grow at a much slower rate. Add the quality of the food to the formula, such as crayfish versus bluegills for bass, and it becomes apparent why one lake yields larger fish than another.

Every body of water has a carrying capacity based on water quality, the shape of the "body," and the total biomass it is capable of producing and sustaining. Better quality water can support more life. Gamefish are at the top of the pyramid. Biomass starts with single-celled alage and ranges through planktonic invertebrates to baitfish and finally to the fishes that anglers try to catch.

Certain species require more room to exist than others. The muskellunge is a prime example. A single adult musky needs an acre or more of water to thrive. Too many fish in a given body of water is counterproductive. Fish tend to produce more offspring of their species when the population is low than when it is high. This is nature's way of maintaining fish stocks at an optimum level.

Turbidity is a limiting factor in a lake, pond, stream or any other water. When sunlight is blocked, photosynthesis is limited, which affects the amount of oxygen. The silt also settles over the bottom, often destroying eggs during the spawn. Suspended silt goes through the gills of fish, irritates the surface, and sometimes causes them to swim at a slower rate, therefore, reducing available oxygen.

Carrying capacity is a theoretical limit that cannot be exceeded permanently. A lake in Louisiana, for example, may temporarily hold more than its carrying capacity, while one in Illinois may carry only half of its capacity. Scientists report that medium-sized lakes, from 1,000 to 5,000 acres, often yield large numbers of fish per acre.

Age and growth information is vital to sucessful fisheries management and conservation. The goal is to insure that a fish lives long enough to spawn at least once. Sexual maturity is not reached for years in some species; therefore, these fish must be protected longer. Fast growing, short-lived species can be caught and kept sooner.

Once a fish reaches a certain age and size, growth becomes much, much slower. A trophy fish does not put on weight very easily, even though it can stalk larger prey and may feed heavily. Food supply and water quality are still critical, but some genetic strains of fish grow larger. Even among humans, some groups of people historically grow larger than others. It is not uncommon for a Watusi of Africa to be seven-feet tall. That height is certainly an exception in other cultures.

Fish Feeding Habits

Many species of fish seldom roam very far from the spot where they were born. It is commonplace for trout to live most of their lives in one small section of stream. Even when they move for the winter or to spawn, they will return to that exact spot the next season. Fish cannot know that food is more plentiful upstream or down or on the other side of a lake. They tend to stay in one small area, regardless of the food supply.

Pelagic ocean fish have a different life style, moving about constantly. Their movements are dictated by water temperature, currents, and the availability of prey. Frequently, gamefish will follow baitfish migrations, feeding on their prey over a considerable distance. Water depth is often a key to locating certain species. If sailfish are found in 120-feet of water at one spot, other sailfish will be at that depth a considerable distance away. No one knows why, but it happens regularly.

When spring migratory tarpon appear in the Florida Keys, they will move from the backcountry side of the Keys to the ocean side. No one can predict the exact day this will happen, but the majority of fish will make the transition at the same time.

Each species has its own game plan for feeding. The largemouth bass, along with the northern pike and muskellunge is an ambush feeder. They prefer to hide or remain stationary, waiting for their prey to come within range, and then strike. Young bass may chase prey a considerable distance, but mature fish seldom do.

Trout fishermen always talk about feeding lanes in a stream where food is carried to the fish. Research has proven that there are certain spots, known best to trout, where they feed. If one fish leaves this area, another will replace it. As young trout take a position, they have to yield to larger fish. These positions are so exact that if one photographed a fish in that spot and made another picture a year later, the eye of the fish in the first photograph could be superimposed on the second if the water flow is identical.

Through eons of time, each species has worked out a survival strategy from which it seldom deviates. That is the life style of the species and young and old live it together. Fishermen study and learn these behavior patterns of their quarry. Once they understand how the fish feed and the habitat it occupies, they have a better chance of success.

LESSON 21

Fish Senses

LESSON
21
Fish Senses

Lesson Objectives

Following this lesson students will:

1. Understand how a fish uses the senses of sound, sight, and smell to locate food.
2. Be able to relate knowledge of these senses to a practical fishing approach.
3. Know why these senses are critical to a fish's survival.
4. Be familiar with the lateral line and near field displacement.
5. Understand how some species use their sense of smell to navigate over great distances.
6. Learn how to approach a fishing spot so as not to spook or alert the fish that may be there.
7. Understand how a fish can strike a black lure on a dark night.
8. Learn the effect of fish scents as attractants.

Materials for the Lesson

1. Several types of commercially available fishing scents.
2. A mounted fish or several different species.
3. Photocopies and an overhead transparency of both the external and internal parts of a fish.
4. Photocopies and an overhead transparency of the graphic depicting the range of a fish's vision.
5. Samples of products to mask human odor.
6. Any material on fish senses from manufacturers.
7. Sample of "smelly" bait such as that used for catfish.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
I. Introduction	It is appropriate that since this lesson covers fish senses that the students utilize their senses. The use of visuals, both photocopied and the overhead transparencies will help the students see the sensory organs of fish. If available, mounted fish provide an opportunity for students to locate the sensory organs. The smell of the "stink" baits will immediately inform students of their effectiveness for fish with highly developed olfactory organs. By the end of the lesson students should be totally aware of how a knowledge of fish senses will help them to be more effective anglers. 1. Introduce students to the objectives of the lesson.
II. Fish Senses	2. Utilizing a mounted fish ask the students to point out its sense organs. Does it have a nose? Does it have eyes? Does it have ears? Can a fish taste? Point out that even though a fish can see, hear, taste, and smell, much like a human, their sense organs are somewhat different, but highly developed and efficient for the environment in which they live.
A. Acoustico-lateral System	3. Distribute the photocopies showing fish external and internal parts and utilize them along with your overhead transparency to discuss the sense organs of fish. Begin with the acoustico-lateral system. The students have already seen that fish do not have external ears or earflaps. However, there are ears buried beneath the skin on either side of the head. Sounds reach the ears through the skin. In some species there is an internal connection between the ear and the swim bladder. This acts a an amplifier, especially helpful for low or soft sounds.

Lesson Content Outline | **Classroom Procedure**

4. Again utilizing the visuals and one of the mounted fish, ask the students to point out the lateral line. If they don't know where it is, point it out on the visual and then trace it on the mounted fish. Ask them what the lateral line is used for. After listing their responses, indicate that it is a second sound-detecting system that fish possess. Indicate that:
   - A. Fish are the only vertabrates to have this organ.
   - B. It responds to low frequency vibrations in the water.
   - C. It is incredibly directional and accurate.
   - D. Within the lateral line area is a series of sensors called neuomasts with tiny hairs connected to nerve fiber leading to the brain. These neuromasts respond to water movement and therefore, fish can hear other fish swimming or a lure in the water. The larger the movement of water, the more easily it is detected.
   - E. Fish seem to be able to distinguish the difference between fish moving in a normal manner and those that are injured or impaired. Predator fish recognize these distress vibrations and prepare for an easy meal.

B. Vision

5. Most fish have excellent near-field vision. Different from a human, fish do not have an iris that opens or closes as light increases or decreases. Their eyes are fixed and light only enters through the center. Discuss the field of vision that fish have. Since their eyes extend from their head, they can see an area of 180 degrees on either side, and their eyes operate indpendently of each other. The vision of the fish overlaps in front of them, where binocular vision occurs, and the only place they cannot see is directly behind the tail. The place of binocular vision is the only area where fish have depth perception. Ask students if they have ever seen a fish turn toward a potential source of food.
6. Scientists believe that fish can see at least 24 different shades and are also aware of variations in brightness and contrast. Color is perceived differently under water than it is in air, as humans usually see it. Colors are determined by various wavelengths of light, and are absorbed by water. The longer waves (reds) are absorbed first. Blues and greens are visible deepest in water. The further from an object beneath water, the less visible the color, until it turns black or very dark. Discuss these factors with students in relation to lures that are popular in your area and also how this could effect their fishing.

Lesson Content Outline	Classroom Procedure
C. Olfactory 1. Location of Food or Natal Stream	7. The sense of smell is particularly important to some fish. Fish use smell to detect a food source, to receive warnings of danger, and some fish such as salmon or eel can navigate by smell. All fish have at least two nostrils or nares in their snout. Most have four, two on each side. Behind these is a chamber lined with sensory pads capable of detecting minute odors. Fish use tiny hairs called cilia to push water into this chamber. The double nostril system allows fish to push water in one and out the other. Those fish with a well-developed olfactory sense have an exceptionally large forebrain. Usually, bottom dwelling and deep water species rely heavily on their sense of smell. Pass around a container of catfish “stink“ bait for the students to smell. Discuss other types of bait that attract fish by smell and list these on the chalkboard. Discuss the sense of smell in relation to chumming and the importance of neutralizing body odors that can be transferred to lures and baits. Some fish can also detect enemies with their acute sense of smell.
2. Chemical Communication-pheromones	With advanced or experienced anglers, also discuss pheromones.
D. Taste and Touch	8. Fish have the ability to distinguish between sweet, sour, salty, and bitter. Taste is important to species such as catfish, which can also locate food by touch using its barbels. The catfish also has taste buds all over its body which helps it locate food in muddy water. Carp, cod and black drum can also taste their food externally.
III. Why Fish Senses are Important	9. Have a general discussion on why it is important to understand fish senses to be a successful angler. It will effect their approach to the water, the behavior in a boat, their lure or bait selection; nearly all aspects of angling. List the responses of the students on the chalkboard.
	10. Distribute any materials related to fish senses that were received from manufacturers.

INTRODUCTION

The nervous system and brain of a fish are poorly developed when compared to higher vertebrates, but these animals are ideally suited to life in the water environment. Their senses are tailored to that medium and function extremely well. Fish are typically nearsighted. Since underwater vision is usually limited to close range, however, the eyes perform adequately.

The sense of smell in some species is much more advanced than it is in humans. These creatures are not only able to detect a hint of an odor, but follow it to its source. Also, some species have well-developed taste and sample their food before devouring it.

Although fish do not have external ears, they hear with acute precision. In addition to internal ears and sound chambers, fish have a lateral line. This unique system is not found in any other vertebrate. It responds to low frequency sounds in the near field with unerring accuracy.

Anglers often erroneously believe that fish think and remember with the sophistication of humans. Actually, they respond well to conditioning, relying on their senses for survival. These senses help fish to find food and escape from their enemies. Understanding how these senses work gives an insight into the underwater world. Armed with that knowledge, an angler can better approach his quarry and is more apt to be successful when fishing.

NARRATIVE

Fish Senses

Acoustico-Lateral System

Sound travels at a rate of about one mile per second through water, which is five times faster than its speed through air. Fish have developed extremely acute hearing, especially on low frequency sounds ranging from 200 to 800 cycles per second. A typical fish can discern sounds from 30 cycles to about 2,000 cycles per second, which is two octaves above middle C.

Anyone who dives below the surface assumes that the underwater world is silent simply because humans have difficulty hearing in that medium. Science has shown that the opposite is true. A moving school of baitfish sends out sound waves. The noise of a tackle box scraped along the deck of a boat is echoed through the water. Footsteps along the bank send vibrations into the water. Some fish can even hear the sound made by a worm wriggling into the bottom. Fish have become adept at detecting and reacting to these various sounds that signal food or danger.

Humans and other mammals have external earflaps, but these are absent in fish. Their ears are buried beneath the skin on either side of the head, are highly developed and are positioned close together. There are no eardrums and no outside openings where water can get in. Sounds reach the ears through the skin, flesh, and bone of the fish. In some species, there is an internal connection between the ear and the swim bladder. The swim bladder acts as a resonator and amplifier, which is particularly helpful in detecting very low or soft sounds.

Any species that has the connection between ear and swim bladder possesses sensitive hearing. One can speculate that fish that spend most of their lives in fast water do not have as acute hearing as those that live in a still water habitat.

Strong hearing capability is not limited to predators or gamefish. It is equally important for prey species to benefit from keen hearing as an escape mechanism. By detecting a predator, they can hide or get out of the way.

Fish have a second sound-detecting system called the lateral line. No other vertebrate has this organ which responds to strong, low frequency vibrations in the water within a range of 20 to 30-feet. It sometimes referred to as the sense of distant touch, because it is incredibly directional and accurate. With it, a fish can locate and strike a black lure on a moonless night in turbid water.

The lateral line starts at the head and extends almost to the tail down each side of the fish. It can be seen visually on most species. Within the lateral line, there are a series of canals lined with sound sensors called neuromasts that are totally sensitive to low frequency sounds. The neuromasts have pods of tiny, sensory hairs connected to nerve fiber that leads to the brain.

Near-field sound occurs when molecules of water are disturbed and pushed. This slight movement of water disturbs the neuromasts which send signals to the brain. Far-field sound takes place when molecules are moved back and forth, but are too distant to be pushed very far in one direction. The ears of a fish receive far-field sound, while the lateral line deals with near-field displacement.

Scientifically, researchers claim that fish cannot discern the direction of far-field sounds, although they can hear them quite clearly and identify them as familiar or threatening. Observations in the field dispute that point. Even in panic, a fish always appears to move away from disturbing sound rather than toward it. Fish do not make a mistake and charge the source of the sound unless they expect food.

When dealing with the lateral line, the larger the cause of the sound, the more easily it is detected. A bigger fish moving through the water pushes more water than a smaller one, which tends to give baitfish warning that something large is approaching.

If one watches a school of fish, it becomes instantly apparent that each school member maintains its position and does not collide with a neighbor, even when the school suddenly changes direction or speed. The lateral line is probably the system that helps a fish keep its distance from the others. When several fish are feeding voraciously, swimming at high speed with sharp turns, the lateral line signals them constantly and they never crash into each other. It boasts amazing accuracy and it is doubtful that most fish could survive without a lateral line system.

For a long time, anglers believed that fish could not hear converstaions above the water because the surface tends to reflect extraneous sound. That theory is no longer widely held, particularly in very shallow water or when a fish is near the surface. Serious fishermen communicate in whispers and then only when it is absolutely necessary to talk. One can test this theory by turning on a radio in a boat and then diving under the water. In many instances, the human can hear the radio, even when he is submerged. If he can hear the sound, a fish certainly is able to detect it.

When a fish is injured or its normal swimming impaired, it gives off distress vibrations. These are totally different sounds than those of a healthy creature or one swimming unencumbered. Predators recognize distress vibrations and home in on them from considerable distances with a purpose. They know that a fish in trouble is an easy meal not requiring the expenditure of much energy. And, the predator seems to know exactly from where the sound is coming even though it is far-field displacement. There is also some evidence that chemical factors may be involved and help predators locate injured prey.

Sharks are notorious for arriving at the scene of a distressed or expired fish. Barracuda in salt water also respond to these distress vibrations as do other predators. The northern pike will appear suddenly when a smaller critter is thrashing around alongside the boat. That's one reason why baitfish suspended on the surface will attract gamefish.

Feeding within a lake, stream, or other body of water often becomes a chain reaction. Fish hear the sounds of other fish feeding and often begin to look for food themselves. The sounds of the tail thumps and splashing can have a positive effect on many fish at the same time.

Over reefs and banks in the ocean, anglers often resort to chumming to attract fish, relying on the smell factor. Actually, most of the chum may be devoured by smaller fish that feast near the boat almost as soon as the chum begins to sink. Fishermen are sometimes concerned that the chum is not reaching their target which happens to be larger gamefish. Frequently, the sound of smaller fish noisily feeding attracts larger gamefish and the mission is accomplished through a combination of sound and smell.

To prove that fish recognize specific sounds, scientists have recorded underwater sounds and then played the recordings in other areas. The sound of porpoises, for example, caused mackerel to panic and display fear. A barracuda was lured right up to an underwater speaker that was broadcasting the sound of feeding jack crevalle. Trout have been observed to begin feeding vigorously when they heard sounds of other trout feeding.

Certain sounds attract and others repel. A sudden noise will often cause a fish to move off before it stops, turns, and begins to investigate. Even a tiny, lightweight lure that lands over a fish may cause a negative reaction temporarily. It's much better to make the presentation beyond where one suspects the fish to be.

Vision

A gamefish may use its sense of smell or hearing to locate its prey, but in most cases the final attack is visual. Predators enjoy excellent vision underwater and they use it to isolate and attack their victims. Fish have eyes very similar to those of humans with a few basic exceptions. One major difference lies in the fact that humans have an iris or diaphragm that opens or closes depending on the amount of light. A fish's eye is fixed and light only enters through the center. Light is blocked when it comes from the edges.

Basically, light comes into the eye, is focused by the lens, and directed to a light-sensitive screen in the back called a retina. The eye of a fish is round and it does not change its shape in an effort to focus. Human eyes are flatter in the front and the lens adjusts to focus the light on the retina. This inability to adjust the shape of the lens causes nearsightedness in fish, allowing them to see clearly at relatively short distances, but items are blurred beyond that. By using a muscle called the retractor lentis, fish can extend their vision. This muscle only comes into play for distance vision and it pulls the lens back toward the retina to focus. The lens in a fish's eye is already set for near vision so the muscle is only used when distance is needed.

Even under the best conditions where the light is unusually bright and the water exceptionally clear, visibility is limited to a few hundred feet. In most conditions, underwater visibility is less than 50 feet and often much closer than that. Typically, almost 99 percent of the light is filtered out in the first 27 feet below the surface. In murky water the majority of light will disappear within the first 10 feet.

It is important to understand that vertical depth and horizontal distance have the same effect on visibility, although looking horizontally within a few feet of the surface provides the benefit of more light.

Since fish do not have an iris, they adjust to changes in light through receptor cells. Most fish have both cone and rod receptors. Cone cells are used during periods of brightness when the light levels are one foot-candle or more. During periods of poor visibility, the rods take over. The rods are about 30 times more sensitive than the cones, but they record only in black and white. The process of changing from rods to cones or vice versa is not instantaneous since it requires at least two hours to switch completely.

During a normal, twenty-four hour period, the process is ongoing. Late in the afternoon, the cone receptors retract and the rods start to come forward. Sometime during the night, the reverse takes place and the fish is ready for the coming of daylight. Predators rely on these rhythms for an advantage in feeding. Anglers know that some of the best fishing takes place very early and again late in the day. Fish feed at these times because they have an advantage in being able to sneak up on their prey and expend less energy.

When a diver drops below the surface of the water, he must turn his head constantly to check around him. He can only see directly in front and is severely limited with a form of tunnel vision. Fish don't have that problem. Instead of having recessed eyes as humans do, theirs are round and extend from either side of the head. Each eye can scan independently of the other, covering an area of 180 degrees or more on either side. There is an area of overlapping in front of the fish, forming an angle of about 45 degrees, where binocular vision occurs. The actual angle varies with the species. The only place a fish cannot see is a narrow lane directly behind the tail.

The sharpest vision occurs when an object is at right angles to the eye, but there is a trade-off. The only area in which a fish has depth perception lies in the zone of binocular vision. That's why one often sees a fish adjust its position to turn toward a possible source of food. This binocular vee starts in front of the fish and not directly against its nose. If a bait or lure passes too close to the fish, it may be difficult or impossible for the fish to see it. The presentation should be at least a foot or so in front. For some species, a presentation at right angles to the eye will bring an instantaneous response as the fish whirls, brings the offering into binocular vision, and strikes.

Fish, like other predators, are alert to any movement. It is more than a conditioned reaction. The beam of light striking the retina moves when the object in view moves. That excites the nerves in the retina and the information is transferred to the brain.

New anglers often question whether or not fish can see color. Scientists point out that the presence of cone receptors in the eye indicate that a fish has the ability to distinguish color. This occurs in practically all of the fish that live in relatively shallow water. Many species of gamefish have the ability to distinguish at least 24 different shades and are aware of variations in brightness and contrast.

Colors are determined by various wavelengths of light. An object absorbs all but one wavelength which is reflected back. The eye sees that object as a single color. Violets and blues are at one end of the scale, while oranges and reds are at the other. Humans are familiar with identifying colors through the medium of air. Water has a different effect, tending to absorb the longer waves (reds) first. Red will disappear within 15 to 20 feet of depth or horizontal distance. Blues and greens penetrate the deepest in water. As a point of reference, the human eye sees chartreuse better than any other color and it is assumed that the same holds for fish.

As depth increases, the loss of color does not occur all at once. A red or yellow or any colored object tends to fade rapidly. The color simply isn't as bright. Eventually, it turns black or a very dark shade when the color is lost. Remember that black is the absence of color, but white is the presence of all colors.

At one time, bass fishermen were led to believe that certain fluorescent fishing lines were highly visible above water, but could not be seen underwater. It was later proven beyond doubt that this statement was in error. Fluorescents underwater are much more visible than non-fluorescent colors and fluorescent line actually appears to have a greater diameter than it actually does.

The background plays an important part on how visible a particular color might be. Certain shades tend to disappear against various backgrounds and it depends whether a fish is viewing the color looking up, down, or horizontally. Keep in mind that a fish looking up at a lure sees the lure in silhouette against the sky. It is the same as looking at a bird against a bright sky and trying to identify the coloration under the wings. In many cases, one can only distinguish shades of black, white, or gray and note the contrast. Similarly, that is the way a surface lure can look to a fish.

As a general rule, consider that most predator fish have excellent vision and they can see color. Their biological rhythms prepare for the coming of darkness and the arrival of dawn. Vision is vital in the final stages of attack and feeding. Fish may reach their prey through smell or sound, but will then switch to the visual mode before striking. Much, of course, depends on the clarity of the water.

Olfactory Senses

The olfactory senses are particularly important to many fish species. With it, they can pick up the scent of a food source, receive warnings of danger, allowing the salmon and eel to navigate by nose. All fish have at least two nostrils or nares in their snout. Most gamefish as well as other species have four nares, two on each side of the snout. That's where the similarity to mammals ends. Air breathers have a tube from the nostrils that lead to the throat; fish do not.

Behind the nares on a fish is a chamber lined with sensory pads capable of detecting minute odors. The key to keen smell is the ability to move water over these pads rapidly. Fish use tiny hairs called cilia to push water into the chamber. The double nostril system allows fish to push water in one and out the other, insuring a stronger and faster flow. A pumping system using the cilia or moving the gills is important. Otherwise, the system is only effective in flowing water or when the fish is swimming.

Smell is handled by the forebrain in the fish's head. Those with well-developed olfactory senses have an exceptionally large forebrain. Traditionally, bottom dwellers and those species living in deep water rely on their sense of smell a great deal, but it is often important to those fish that inhabit shallow water. The northern pike has a particularly poor sense of smell and does not feed well at night. Any species that does feed at night probably has a well-developed sense of smell.

Chumming, the technique of broadcasting natural food in a current, demonstrates that fish can use their sense of smell to track. They will turn into the chum slick and follow it to its source. Gamefish often use smell to track a food source and then switch to vision when they are close. Many, however, have the ability to find food by smell alone.

Experts have difficulty explaining how a fish can sort out thousands of odors in a body of water and react to the ones that are important. Species such as the salmon can respond to traces of a chemical in such small quantities that sensitive instruments have trouble measuring it.

Smell is also used to detect the presence of enemies. Coho and Chinook salmon have reacted to incredibly small amounts of odors from seals and sea lions. During one test, the fish detected the odor in concentrations of one part per *80 billion* or two-hundreths of a drop in a 23,000 gallon swimming pool. It is precisely this sense of smell that may allow the salmon to return to a stream and the precise spot of its birth. No one fully understands how the salmon does it, but researchers have proven that it involves the salmon's ability to detect minute quantities of various smells.

Repeated experiments have shown that fish react negatively to certain smells that spell danger such as those given off by a bear paw or the human hand. Humans have a substance called L-serine which is an amino acid. When they touch bait, a lure, line, and so forth, this substance transfers and the fish can smell it. Expert anglers often rub one of the fish scents, a neutralizing chemical, or even natural bait over their hands to mask the scent normally given off. It really makes a difference in catching fish.

Pheromone is the term describing a smell that is used for some form of communication among fish. Baitfish, for example, often panic at the smell of a wounded school member. There is a substance in the skin of baitfish called schreckstoff, "fright substance," and it is visible under a microscope. When a predator grabs or eats a baitfish, schreckstoff is given off and it warns the other baitfish to stay clear of the area.

Certain minnows recognize the smell of predators and scientists believe this is instinctual rather than learned. They introduced the odor of pike into a tank of baitfish that had never seen a pike and the fish reacted.

Smell is used among school members for various rituals including mating. It is an important sense, but one which humans have difficulty understanding because our own olfactory senses are less than acute. Certain feeders such as catfish or sharks depend heavily on smell to locate their prey and can accomplish that chore with unerring accuracy.

Taste and Touch

No discussion of the senses would be complete without at least passing mention of taste and touch. Fish do have the ability to distinguish between sweet, sour, salty, and bitter, although it is questionable how much taste is used by most gamefish. Taste is important to species such as sturgeon and the catfish, which can also locate food by touch using barbels, the whiskers around the mouth.

Taste buds are usually external, but internal ones occur in some species. The catfish has taste buds all over its body, including its tail, which help it to locate and select food in muddy or silty water. As mud is stirred up, the sense of smell becomes confused and that's why touch and taste suddenly become important.

Carp also have the ability to taste their food externally as do cod and black drum in salt water. These species often test their food first before they take it in their mouth. That's why those who fish for these species are patient and wait until the fish runs off with the bait before setting the hook.

Why Fish Senses Are Important

The immediate desire to catch fish often overshadows the more logical approach of understanding them first. When an angler knows how a fish feeds and the ways in which a fish uses its various senses, he is better equipped to meet the challenge of fishing. Simply drowning a bait or mechanically cranking a lure spans a very narrow angling corridor. It becomes a hit and miss effort that lacks consistency.

Each fish species has its own life style and even within a given family of fishes, there are subtle differences. Rainbow and brown trout may be found in the same stream, but they are not the same fish and show distinctive preferences and habits.

A basic familiarity with tackle and techniques may give and angler an excellent start, but only through an understanding of the habits and habitat of the fish will an angler become accomplished.

How to Approach Fish

Most species are acutely alert to what is going on around them. They have keen eyesight that encompasses almost 360 degrees, leaving only a small zone behind them as a blind spot. Fish also have the ability to see out of the water and spot anglers just as easily as fishermen can see the fish.

When a person looks at a fish underwater, the fish is actually closer than it appears. This is because light rays bend or are refracted as they pass from the air into the water. From the fish's viewpoint, refraction creates a periscope effect. An angler standing on the bank does not appear to be on the bank, but almost directly over the fish. Any movement and the [illegible] that something is unnatural.

Once a fish has been alerted, it is [illegible] catch than one totally unaware of a fisherman's presence. That's why the approach is so critical. Fish always face into the flow of water. In moving water, serious anglers work upstream into the current. They are taking advantage of a fish's blind spot to its rear. The swifter the current or the deeper a fish happens to be, the more difficult it is for the fish to spot a person.

When walking along the bank, the sound and vibrations of footsteps are transmitted into the water. If bluegills are in the shallows, one can see them ease into deeper water as an angler approaches. The answer lies in staying well back from the edge of the water and then keeping a low profile. White or bright colored clothing is easily seen by fish. Shirts, trousers, jackets, and hats should be colored to blend into the background.

The commando tactic of keeping low is very valid when approaching a stream, pond, lake, or anything else on foot. The closer to the ground one happens to be, the less likely a fish will see him. Even when casting, it is important to keep the rod tip fairly low. If a fish detects movement in the rod, it will become very wary.

Aboard a boat, silence is the golden rule. Any sound transmitted through the hull and into the water telegraphs the position of the boat. Bright clothing makes anglers visible and movement is quickly seen. Too many fishermen roar into an area at high speed, sending damaging waves against the shoreline and alarming fish with the sound of the engine. It makes more sense to enter the fishing zone slowly and preferably from a di[illegible] you don't expect the fish to be. Running over them may force them to change locations before the first cast is made.

The best advice is to think through each situation, remembering that fish see, hear, and smell very well. Approach quietly and without being seen. Keep the noise level down and maintain a low profile, minimizing movement. The results of these tactics will be obvious.

LESSON 22

Food Chains and Ecology

LESSON

22

Food Chains and Ecology

Lesson Objectives

Following this lesson students will:

1. Understand the basic relationship of fish to their environment.
2. Know the importance of carrying capacity and dissolved oxygen content.
3. Know why energy flow is important to ecology.
4. Be familiar with aquatic food chains and the interrelationship of producers, consumers, decomposers, and predators.
5. Understand predator/prey relationships and how they apply to the food chain.
6. Comprehend how to use food chain information to catch fish.

Materials for the Lesson

1. Overhead transparencies and photocopies of the appropriate graphics fom the appendix.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
	Due to the content of this lesson you may want to invite a fisheries biologist to participate and discuss many of the scientific aspects of this subject. He/she may also be able to bring a film or filmstrip to illustrate some of the material. 1. Introduce students to the lesson objectives.
I. Basic Ecological Principles A. Energy Flow B. Carrying Capacity C. Dissolved Oxygen and Water Temperature D. Recycling	2. Begin the discussion by informing the students that angling success can be increased if they understand several basic ecological principles and how aquatic food chains work. 3. Explain that aquatic life is based on an energy flow, with a broad base and a narrow peak, much like a pyramid. Top predators, and especially those fish that are the most exciting to catch, are at the top of this pyramid. Using the graphic, explain this energy flow and the fact that only about 10% of the energy at one level is passed on to the next. Explain that the base of the pyramid of the ecosystem are the primary producers, which rely on the sun. The energy possessed by these plants is passed on to plant eaters, who are the first level of consumers, who are eaten by the meat eaters, and on up the line. Each species of aquatic life finds it niche in this flow of energy. 4. The previous discussion leads directly into the carrying capacity of bodies of water. Each is limited in the number of living things that can be present. Water quality has a great effect on carrying capacity, as does the food supply, and the amount of competition. Some waters are much more productive than others based on their depth and the length of the growing season. 5. Fish need oxygen to live and through the process of photosynthesis, aquatic plants supply this to aquatic life. Water quality, and water depth, allowing the sun to penetrate plants, allows this process to continue. Turbidity, pollution, ice covered with snow, and plant decomposition can retard this. Also, the warmer the water, the less oxygen it can hold and the more needed by fish.

Lesson Content Outline	Classroom Procedure
II. Aquatic Food Chains A. Prodcers B. Consumers C. Decomposers D. Predator/prey E. Using this Information in Fishing	6. Every living thing belongs to a food chain. The sun is the basic source of energy. Lead a discussion of the role of producers, consumers, decomposers, and predator/prey relationships around the concept of a food chain. Ask students to relate this concept to their own lives and then to that of fish in the aquatic environment. 7. The concepts presented in this lesson have much significance for anglers. Ask students to draw conclusions of how this knowledge can help them become better anglers. The text can provide much useful information and suggestions.

INTRODUCTION

The word "ecology" escaped from the scientific lexicon in the late 1960's and entered the public domain as a rallying cry. People suddenly focused their attention on environment, bemoaned pollution, worried about wetlands, and talked recyling. By definition, ecology is the study of the way in which all forms of life relate to their environment which includes each other. It does not mean a clean, pollution-free earth.

Life cannot exist in a vacuum. There are interactions with living organisms as well as the non-living. A definite energy flow exists. Survival for a given species in a watery world may seem simple, but it becomes part of an intricate web in which one factor depends on another and another.

The aquatic food chain consisting of producers, consumers, decomposers, and predators showcases life's interdependency under the surface of a pond, stream, lake, estuary, or ocean. Dissolved oxygen and water temperature become vital factors in any life support system. Each body of water has a carrying capacity that regulates the number of animals within a given area.

Knowledge is an angler's strongest ally. Understanding the food chain and how each species relates to its environment become significant factors in locating and catching fish. It also serves as the cornerstone in protecting the habitat.

NARRATIVE

Basic Ecological Principles

Ecology focuses on interactions and interrelationships of organisms and their environment. There are specialities within the discipline through which the researcher or observer goes beyond the individual or the species to concentrate on behavior, population, the community, and the ecosystem.

From the practical standpoint of fishing, ecology considers such factors as water conditions, nearby objects, available food, potential enemies, and the watery environment in general. It is difficult for air-breathing humans to understand what it is like to live beneath the surface of the water. As a medium, pure water is tasteless, colorless, and odorless, but it is 780 times as dense as air.

Anyone who has attempted to swim underwater knows how difficult it is to propel the body. Fish seem to do it with ease, benefiting from a particular shape or form that has evolved over time. Water also creates a neutral buoyancy that counteracts the effects of gravity. A relatively small person can support a 220-pound man in the water with one hand. Fish live in a weightless world.

The air around us contains about 18 percent oxygen, which is vital to our survival. Fish also need oxygen, but the amount dissolved in water is much, much less. Typically, water contains about .0008 percent oxygen which translates to eight parts per million. To glean this vital gas from water, animals living in that medium must develop highly efficient gills. A difference as minute as one or two parts per million can determine whether or not a fish can survive in a given body of water. Think of the effect on humans if 1/4–1/3 of the oxygen supply was removed.

The human body is composed primarily of saline water. That's not really a problem in a relatively dry atmosphere, but it is to fish. They, too, contain a considerable quantity of salt water. Only a thin layer of skin separates this fluid from the water around them. In the ocean, osmosis through the skin takes water out of a fish's body and the animal must replenish it by drinking sea water. Just the opposite occurs in freshwater. Reverse osmosis causes water to enter a fish's body through the skin. Since the body fluids are saline, this freshwater must be flushed through the kidneys. It's equally important to know that dissolved particles in the water enter the body the same way. That's why the flesh of certain fish can contain chemicals found in the water in which they swim.

As a basic ecological rule, the more tolerant of varying conditions an organism happens to be, the better its chances for long-term survival. Those that can only exist within a narrow band are at the mercy of the vagaries of nature.

Energy Flow

Energy flow becomes the common denominator (medium of exchange) for any ecosystem. Within any food chain, there is a transfer of energy. Radiant energy from the sun is vital to the plants, which are the primary producers. This energy is stored by chlorophyll containing plants as sugars or carbohydrates. Herbivores or plant eaters are the first level of consumers. Carnivores or meat eaters feed on herbivores and other carnivores. Omnivores feed on both plants and meat.

The chemical energy used at each level is not recoverable. As part of the process and particularly through respiration, heat is given off into the atmosphere. At each level of the food chain, there is less energy available than at the level below. This is an important concept and involves the ten percent rule. Only ten percent of the useful energy at one level will be passed on to the next level. This creates a pyramid effect with a broad base, steep sides, and a narrow peak. Top predators and particularly those fish that are most exciting and rewarding to catch sit at the top of the pyramid. That's why there are so few of them compared to baitfish and other creatures of the underwater world. In this sense, fisheries management, centered around predators, becomes quite different from wildlife management which concentrates on prey animals. The living creatures in an area become part of a very complex system of energy relationships known as a food chain or a food web.

Each species finds its niche in the web in terms of foods it will eat and places it can live. Most creatures try to eliminate as much competition as possible through unique adaptations. Those animals that can tolerate and digest a varied diet have a better chance for survival.

Carrying Capacity

Every body of water, including the oceans of the world, have finite limits on the number of each living thing they can support. This ceiling or upper limit is called carrying capacity and it is affected by several variables. Water quality and condition may control a given species directly and indirectly. In the direct sense, the spawn and juveniles may be limited. Indirectly, if the biological producitivity of the water in terms of food supply drops, the carrying capacity immediately reflects this change.

It is not uncommon to find vast quantities of stunted bluegills in a farm pond, victims of competition for a dwindling food supply. Overcrowding produces its own effects. Scientists believe that many species limit production of young when conditions are crowded, but expand the spawn when an area is available for repopulation.

Food supplies play a vital role in determining the carrying capacity and the size of the fish in a particular body of water. The concept focuses on the pyramid discussed above and the ten percent rule. Walleye require a large area to forage and there are seldom very many of them in any lake or river. It's no wonder that to produce and sustain a single 10-pound walleye requires a base of about 100 pounds of perch annually. One hundred pounds of perch depend on one ton of minnows. Those minnows rely on 5 tons of worms and insects for their survival and the worms and insects need 50 tons of plants for their support. In this example of a pyramid, it takes 50 tons of plants for one 10-pound walleye.

The amount of food available and the competition for it plays a critical role in determining how many of any species will reside in a body of water and the size they will attain. Research has shown that medium sized lakes usually produce more fish per acre than large ones. Shallower lakes boast more productivity than deeper ones because of greater shallow shoreline where sunlight can reach the bottom over a greater area. Growing season also plays a part. In the southern regions where the weather is warmer and the growing season longer, lakes yield greater returns.

Importance of Oxygen and Water Temperature

Without an adequate supply of oxygen, fish cannot survive. There is no substitute, so it becomes a critical ecological limitation. Aquatic plants take in carbon dioxide in the water and give off oxygen with the help of the sun through the process of photosynthesis. When the water is unpolluted and relatively shallow, rooted plants and floating algae insure the necessary oxygen for other forms of life.

Additional oxygen enters the water from the air, although this is a slow process. In a moving stream, water tumbling over rocks or cascading over falls picks up quantities of oxygen from the air. However, if the water has too much oxygen, it will release the excess into the atmosphere until it maintains a fully saturated condition.

Murky water screens out sunlight and makes photosynthesis more difficult. Turbidity, in the form of silt, also settles on the bottom, smothering plants and even the eggs of fish. When the water becomes overfertilized and polluted, there is usually a serious lack of oxygen. Decomposition of plant and animal life uses up a considerable amount of oxygen, often compounding the problem.

Even when ice covers a pond or lake, photosynthesis can continue. Snow becomes the problem. Five inches of dry snow on top of ice can block out almost all of the light necessary for photosynthesis, causing oxygen to be depleted quickly in shallow lakes.

Fish tend to linger in weedbeds during the summer months. Fish will also congregate where underwater springs enter a lake. In a stream, look for fish near riffles and fast water when oxygen supplies dwindle.

There is an important relationship between oxygen and temperature. The warmer the water temperature, the more oxygen a fish requires and the less the water can hold. Water temperature is perhaps the single, most important factor in determining where fish will be and how they will behave. These are cold blooded creatures with body temperatures that adjust to the temperatures of the surrounding water. Rapid heating or cooling of water stresses their physiological processes. A fish caught in water that cools quickly may die.

Each species has its own comfort and tolerance level. They tend to seek the most comfortable environment, assuming, of course, that there is adequate oxygen. For the angler, a thermometer is one of the most vital items of fishing gear. Sometimes, a temperature variation of only one degree will spell the difference between fish and no fish as they can sense minute variations in temperature and respond to them. It's extremely important to monitor temperature at all times.

There are some general observations worth remembering. Shallow flats warm and cool more quickly than deeper water. During a cold snap, fish will leave the shallows for the depths, but return when a warming trend develops. When the heat of summer raises water temperatures, fish tend to move into deeper parts where more comfortable temperatures prevail. Bass fishermen know that early in the season, some of the best action occurs in coves and backwaters, because temperatures are slightly warmer than in other parts of the lake.

Recycling

Although much of the energy flow within an ecosystem is lost, certain checmicals and nutrients must be recycled if the process of generating new energy is to continue. Water evaporates and then falls to earth again in the form of rain or snow. The runoff into streams, lakes, estuaries, and eventually the ocean carries chemicals and nutrients.

Every organic compound contains carbon and hydrogen. Carbon is separated during photosynthesis and then put back in the form of carbon dioxide through respiration, fermentation, or combustion. The decomposers use oxygen and give off carbon dioxide.

Oxygen serves to receive hydrogen which forms water. During photosynthesis, a separation occurs and oxygen goes back into the atmosphere. Certain plants produce nitrogenous materials and this vital nutrient completes its cycle.

These, of course, are simplifications of extremely complex, but vital processes. Without the recycling of these chemicals, life simply would not exist. There are other nutrients necessary, but carbon, hydrogen, and nitrogen are the primary ones.

Aquatic Food Chains

Every living thing belongs to a food chain. These chains are not isolated, but actually part of extremely complex food webs. The sun is the basic source of energy. Oxygen and simple foods are produced through photosynthesis. Food is vital for an organism to repair tissues, to grow, and to have energy for basic body functions.

Plants form the broad base of the pyramid, converting the sun's energy into their own food. Rooted plants streaming upward from the bottom of a pond or lake are extremely visible, but the food chain usually begins with one-celled, microscopic organisms so tiny that they are almost impossible to see with the naked eye. These plants are called "phytoplankton". "Plankton" is all of the small life in the water. "Zooplankton" defines extremely small animals that feed on the microscopic plants.

Larger aquatic animals including many species of fish feed on both phytoplankton and zooplankton. They, in turn, become meals for larger fish.

Producers

Green plants take the energy from the sun, along with water that supplies hydrogen and carbon dioxide, and create their own food, giving off oxygen as a byproduct. These are the producers and animal life cannot exist without them. They are the basis for all life on earth. Because these plants are self-sufficient, they are called "autotrophs" from the Greek "auto" meaning "self" and "trophein" meaning "to nourish".

Plants have the ability to manufacture sugars, fats, proteins and other compounds from basic inorganic materials. Animals lack the ability to do this. Primary production measures the rate at which plants convert inorganic materials to food. Some of this food is used by the plants for their own survival. The excess or net primary productivity determines the amount of food available for other life forms. The more food the primary producers make, the greater the ecosystem that can be supported.

A significant percentage of the food produced on the primary level is lost to the next level. Not all of the plants and the phytoplankton are eaten. Some die of natural causes and become detritus for the decomposers. This is also an important function, because in the process, certain vital chemicals are returned to the system.

Rate of conversion must also be considered. The faster the energy from the producers is transferred to the next level, the smaller the loss of energy. Consider that plankton may bloom (reach abundance) in a day or two, but it takes the better part of a year for certain rooted plants to form and begin to grow.

If animals throughout the food chain are to survive, there must always be more food than necessary at each level. This enables the food sources to reproduce and renew themselves. If they are completely destroyed or seriously diminished in a given area, it would have a catastrophic effect on higher orders that depend on the food chain for their survival.

Consumers

Animals and non-green plants do not manufacture their own food and cannot be considered self-nourished. They are called heterotrophs meaning that they are "other-nourished." The basic animals in this group are herbivorous, relying on green plants for their food. Because they feed on the producers, they are considered to be consumers of the first order and include zooplankton, worms, shrimp, clams, insects, and even some fishes.

The food gleaned from plants by herbivores or first order consumers must not only provide energy, but very specific organic compounds and nutrients. The absence of any of these even for a very brief period will stop the production of protein. An imbalance will change the metabolic rate and prolonged absences of vital chemicals will cause death.

The carnivores, or meat eaters, form the second order of consumers. Some scientists call these animals foragers. They must expend considerable energy to search for their food and capture it. Parasites that fall into this group must disperse their young where there is an adequate food supply. Many of the panfish such as bluegills and crappie fall into this category along with crayfish, shiners, alewives, and menhaden.

It is within this group that the delicate balance of nature first becomes somewhat visible to the lay person. If these carnivores destroy most of their food source, they and their offspring will perish through starvation. That enables the first order of consumers to reestablish itself so that the balance can be achieved once again. Seldom, however, does a carnivore totally eliminate its supply of food. Very few organisms depend on a single food source for survival. The Everglades kite with its dependency on the apple snail is an exception.

Predators sit at the top of the consumers, preying on first and second order fish. These are the gamefish that many anglers want to catch and include pike, muskie, bass, trout, salmon, tuna, tarpon, and bluefish. It takes a staggering amount of productivity and energy transfer on the lower levels to support a meaningful population of these predators.

Decomposers

Organic compounds remain trapped in dead plants and animals, waiting to release that energy back into the system. Bacteria, yeasts, and microbes are described as the non-green plants and they wait to break down detritus and dead animals. Scavengers have a digestive cavity that simplifies food for assimilation. The decomposers secrete digestive juices directly on the plant or animal.

Decomposers can remain dormant for extended periods of time, conserving their energy and waiting for the opportunity to feed on dead plants or animals. They multiply at an incredible rate once food is present. Even the wastes from the decomposers are utilized and further broken down by other organisms.

The basic nutrients released through this process go back into the system to be used by plants during photosynthesis and by other animals in their battle for life. Not all decomposers work rapidly. Some take considerable time before they can adequately complete the recycling phase. Certain chemicals such as those used in some pesticides and herbicides can only be attacked by a small percentage of the decomposers and even that takes a long time. Scientists are concerned that these substances will linger in certain ecosystems for long periods of time.

Wind, currents, water flow, and other factors help to distribute the decomposers. They continue to travel until they find the right conditions. Then, they tend to remain and produce more of their species until the job is done. Most decomposers are specialists working only on a limited portion of the food source. One might think of the process in terms of a disassembly line.

Predator/Prey Relationships

Predators remain close to their source of food. Some lie in ambush, protected by natural structure and their own coloration until a victim comes within the range. The capture occurs with lightning speed as the predator lunges out at its prey. Largemouth bass, barracuda, pike, muskies, trout, and even the flounder often employ this technique.

The alternative lies in cruising around until prey is located. Most of the pelagic ocean species follow this procedure, often forming schools for increased efficiency. A school of predators has the advantage of disrupting and disorienting its prey. The baitfish aren't certain which predator is about to attack, so it is more difficult to avoid an aggressor.

A predator selects and attacks one specific victim at a time. When baitfish school, it is difficult for a predator to select a single member and charge it. The facade of the school becomes a shimmering mass that changes constantly.

Anyone who has monitored gamefish behavior knows that predators often lurk below their prey which allows them top pick off one that looks disabled or different. The effect of this predatory system is to cull out the sick and the young. By doing so, predators are not greatly decimating the total food supply in the chain or web.

A baitfish that strays from the pack becomes an easier target and is frequently attacked the moment it gets separated. If there is something different about a specific fish that enables the predator to maintain eye contact with it, that fish is in serious trouble. Scientists report that most predators look for the easy meals and ignore the healthy fish in the middle of a bait school. Some species will charge bait in the hope of causing disorientation, but the successful predator still runs down its victims one at a time.

The prey sometimes becomes the predator at certain stages of development by feeding on eggs, fry, or juveniles. Bluegills, for example, raid the nests of largemouth bass and eat the eggs. The male bass tries to drive them off, but isn't always successful. Once the eggs hatch and the fry scatter, they become fair game for many of the species that will later become the prey. In this reversal of roles, populations are kept in check and the balance of nature maintained.

Using Food Chain Information in Fishing

A study of food chains quickly demonstrates that waters rich in producers will generate more consumers, particularly those of higher orders. As a primary step, anglers should begin to analyze the water they fish, attempting, at least superficially, to determine if an abundance of plants,including algae, exists and if they can observe significant quantities of bait.

Without a firm base, the number of predators at the top will be severely limited. Experienced fishermen alway feel more comfortable working water that shows livings things, even if those animals are not the fish they plan to catch. If, for example, you overturn a number of rocks at the side of a lake and find crayfish, you can almost bet that there will be bass and particularly smallmouths. In contrast, tadpoles in a pond indicate few bass. In a trout stream, insect larvae attached to rocks, is an indication that the water generates plenty of food for trout.

On the negative side, water that is stagnant, polluted, or otherwise shows signs of oxygen depletion will hold a much smaller crop of fish. The key to catching fish lies in fishing productive waters. Even before one worries about technique, it is imperative to select waters where there is a strong food chain and fish populations are close to carrying capacity.

Using food chains as a guide, an angler begins to understand the types of food a given species prefers. Usually, the diet covers a relatively broad base but there are certainly primary targets. Whether one relies on natural bait or artificials, the idea centers on giving the fish what they want or what they would find naturally in those waters. In terms of trout feeding on insects, this is called "matching the hatch", but the concept goes far beyond that. If shiners are prevalent in a body of water, they make an excellent bait. The same approach goes for menhaden, sardines, pilchards, or other baitfish in salt water. Find out what fish are feeding on and then try to present the same thing or a reasonable imitation in the form of an artificial bait.

Since most angling effort is directed toward at least second order carnivores, how they find food is important. Those that ambush their prey will usually lie close to some form of cover or use their own disruptive coloration to help them blend into the terrain. They wait motionless for their prey to approach and then launch a very swift and accurate attack. Knowing this, one must make sure the bait or lure is worked very close to the area where these fish are most apt to lie. They will not chase their prey for great distances. If the offering does not land close enough, there is an excellent chance it will be ignored.

Fish in moving water maintain a very precise lie. This is particuarly true of trout, char, and salmon. When feeding on dirft carried by the moving water, they seldom move more than a foot or two in either lateral direction to take their prey. If the presentation does not drift naturally through this zone, the chances of a response from the fish are minimal.

The heart of predator/prey relationships focuses on the fact the predators select and attack one specific victim at a time and that they prefer a victim that is isolated, disabled, or different-looking. A baitfish tethered to a hook and allowed to swim among a school of the same bait will be ferreted out and struck by a predator. The fact that the prey in question behaves differently is all it takes.

If that bait is kept near the school, but on the fringes, there is an even better chance that a predator will find it. Stragglers are the first to be picked off. It's no different with artificial lures. Assuming the cast is made into a school of baitfish, the retrieve will draw the lure away from the pack, enabling any larger fish nearby to isolate and attack it. One trick that works well with schools of baitfish is to use heavier lures that will sink beneath the prey to the area where predators are most likely to be. Remember that they prefer to lurk beneath their victims and strike upward rather than downward. Most attacks start either horizontally or toward the surface, rather than toward the bottom.

The successful angler uses all of the information he possesses to increase his chances. By understanding the ecological facets of the game and applying the basics of the food chain, one can select the best waters and then present a bait or lure in the areas most likely to hold the quarry.

LESSON 23

Aquatic Communities—Examples and Adaptation

LESSON

23

Aquatic Communities—Examples and Adaptations

Lesson Objectives

Following this lesson students will:

1. Understand different aquatic communities.
2. Know that anaimals live at nearly all water levels.
3. Be able to compare aquatic communities in different types of water.
4. Know how organisms react to specific habitat.
5. Understand the food chain.
6. Know why each aquatic ommunity contains its own species of fish.

Materials for the Lesson

1. Overhead transparencies and photocopies of the graphics in the appendix.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
	Based upon your geographic location, you may choose to teach all or just a portion of this lesson. Also, you may again wish to invite a fisheries biologist or science teacher to help with the content of the lesson.
	1. Introduce students to the lesson objectives.
I. Ponds and Lakes A. Surface B. Open Water—Pelagic C. Shoreline—Littoral D. Bottom—Benthic	2. Define the terms, population and community. A population is a group of organisms of the same species with similar ecological requirements. A community is a number of different populations living in a prescribed area or physical habitat. Indicate that these will be discussed in relation to a number of different types of aquatic environments.
II. Rivers and Streams A. Shore Zones B. Bottom C. Riffle Pools	3. Briefly review the concepts of the food chain and energy flow. Both are relevant to the content of this lesson.
III. Estuaries **IV. Marshes and Wetlands**	4. Discuss ponds and lakes and the zones where aquatic life will be found. These include the: A. Surface B. Open Water C. Shoreline D. Bottom

Lesson Content Outline

V. **Oceans**
  A. Inter-Tidal
  B. Coastal Waters
  C. Open Ocean

Classroom Procedure

Discuss these zones, how fish feed, what species most often utilize these zones, what types of foods are available, what types of plants (if any) will be found in each, and what types of organisms other than fish will be found in each area or zone. The food chain and energy flow can also be discussed in relation to each zone as well as what this information can mean to anglers.

5. Discuss the unique feature of rivers and streams—their constant unidirectional flow. Ask students to compare this type of aquatic environment to that of lakes and ponds. Discuss what influence rainfall, drought, water releases and snow melts have on this type of aquatic environment. Discuss the zones or areas of rivers and streams including:
   A. Shore zones
   B. The bottom
   C. Riffle Pools

   Compare life in these areas to life in lakes and ponds, how and what fish eat, and where fish would be found in each zone. Ask why it is important for anglers to know this information.
6. Discuss the unique features of an estuary and ask if students can name any in your area. These mixing zones of fresh and salt water host a wide variety of fish and other life, including barnacles in areas of higher salinity. Ask students to compare this aquatic environment to the ones previously considered.
7. Marshes and wetlands have specific characteristics and important functions. Discuss these and include their importance as breeding and feeding grounds, the production of nutrients, and some of their basic characteristics in terms of plant life and soils.
8. Oceans cover nearly three-quarters of the earth's surface and host an amazing variety of plant and animal life. Discuss these in relation to the:
   A. Intertidal Zone
   B. Coastal Waters
   C. Open Ocean

INTRODUCTION

By definition, a population is a group of organisms of the same species with similar ecological requirements. A community is an assemblage of varied populations living in a prescribed area or physical habitat. All of these organisms depend on non-living portions of the environment for survival. There is a delicate balance with each species restricted by one or more limiting factors.

Successful recreational angling depends as much on mental exercise as physical activity. Understanding an aquatic environment and reactions of a species is vital in determining where fish will be and how they will respond. For example, insect life is a major food source for stream trout. Absence of necessary insect species affects the size of the fish and forces the trout to turn to other food sources.

In this lesson, students will study aquatic habitats and learn how different species react. The food chain is placed in a practical perspective, based on the type of water and specific areas within that water.

NARRATIVE

Each type of water has its own characteristics. Organisms have the ability to tolerate changes, or perish. Water levels constantly change; oxygen content varies; and temperatures fluctuate. Competition for existing habitat is keen, often involving several species battling for the same food or space. The processes of natural selection and adaptation determine which species will survive and which will not.

A population is a group of organisms of a single species in the same area at the same time. These organisms depend on the non-living portion of the environment for their survival, interacting with it on a continuing basis. A community is several populations living in a prescribed area or physical habitat. A major community is somewhat independent from other communities while a minor community usually has a close relationship to other communities. A log in a pond may form a minor community, but the pond, itself, is a major community. The ocean is also a major community and requires only energy from the sun. However, there are numerous minor communities in an ocean.

A community has an organization or chain. Energy flows through the food chain from the lowest level to the highest. Over time, the species in a community may change, but the replacements may perform the same functions. Producers (consumers that prey on one another), scavengers, and decomposers all exist in an aquatic community.

Within a given habitat, each species has its own niche. The resource is spread among many organisms. Bluegills may live near the bottom, feeding on insects and small fish. The catfish also lives near the bottom, but it is more of a scavenger. Shad feed on plankton and bass feast on shad. Other animals, including humans, may make a meal of the bass.

Ponds and Lakes

Lakes and ponds are considered to be standing waters. There may be a slight current moving through an impoundment, but compared to those in a stream or river, currents in a lake are negligible.

Farm ponds are often designed to be catch basins, tailored to hold runoff from rains. Larger impoundments are used to store water for generating electricity, as a source of water for irrigation, or as drinking water for cities, and may have similar characteristics in terms of water levels. Significant drawdowns may occur at certain times of the year when they are utilized to supply water during periods of reduced rainfall. Drastic drawdowns may tamper with spawning, destroy shoreline vegetation, and even trap organisms in pools that dry up. To survive, fish must adjust to these changing conditions and move to areas that satisfy their needs, or die.

Surface

Organisms that live in the narrow zone at the surface of the water are known as neuston. A film forms on top of the water and serves as a "barrier" with the air. The molecules in this film are extremely cohesive and form a base for a variety of organisms. Some remain on the underside of the film, suspending from it while others are limited to the top portion. Looking closely at the surface, it is possible to see very small animals that look like dust. During periods of abundance, so many of these tiny creatures are on the surface that it looks as if the water is coated.

To certain species of fish, the surface becomes a feeding zone. Insects may fall on the surface and become fair game for bluegill, trout, and bass. Small baitfish sometimes hover just under the surface film where they appear as silhouettes to larger fish below. A frog swimming across the surface of the water may become a target for a larger predator.

Fish are extremely alert to feeding opportunities at the surface and respond to the sounds made by other fish breaking water to engulf a prey. Anything moving across the water's surface creates some type of disturbance guaranteed to attract attention. If the water is relatively shallow and the sun is shining, the shadow of anything on the surface generally appears on the bottom. This, too, will telegraph a message to fish that something is happening above them.

Open Water-Pelagic

Plankton is the general term applied to very small organisms moved by wind or current. Animals are known as "zooplankton" and plants are called "phytoplankton". Algae make up the tiniest forms of phytoplankton and become food for forms of zooplankton including protozoans, rotifers, and miniature crustacea.

Distribution of plankton is not uniform. Sheltered areas of a lake or pond may contain heavier concentrations referred to as a "bloom" that changes the color of the surface water. Heavy concentrations may occur in open waters where currents cause convergence. Water has to be relatively still for plankton to exist, and almost all plankton has the ability to float. Small numbers of plankton are carried in streams but are not produced in fast-moving streams, rather in standing water such as a lake or pond.

Baitfish roam open areas of a lake, feeding on plankton. Predators follow the baitfish and devour them, thus continuing the food chain. Fish that spend a significant amount of time in open water are known as pelagic species. Striped bass stocked in a fresh water impoundment often fall in this category as well as salmon in the Great Lakes. Both prefer the open water and follow the food supply.

There are times when species such as the largemouth bass abandon cover and prowl open water, chasing schools of bait. Open water areas can be important to an angler, particularly when there is an abundance of baitfish. Predators tend to lurk below their victims, forcing the smaller fish toward the surface. Hence, signs of baitfish on top of the water can be a tip-off to anglers and is usually worthy of investigation.

When larger fish feed on bait, it is often possible to see their splashes or boils. Predators may take their prey just under the surface and turn downward immediately after striking their victim. The rapid turn and strong tailbeat sends an easily spotted swirl to the surface. Frantic movement of bait is another tip-off that larger fish are shadowing the school. Learning to read these signals is an important facet of finding fish in open water.

Shoreline—Littoral

The shallow area along a shoreline is known as the littoral zone and is critical to the production of rooted plants. In many cases, light penetrates the water all the way to the bottom, making it possible for various plants to grow and thrive. Emergent plants are found closest to shore. These include cattails, rushes, and various marsh grasses and plants that grow in damp spots and often extend into the shallow portion of a lake or pond.

Floating-leaved plants, such as water lilies and pond weeds form the next group. They grow in water to about 10 feet deep and can be recognized by their slender, flexible stems and leaves that float on the surface. Fields of water lilies usually mean that the area is of relatively uniform depth and is probably less than 10 feet deep.

Submerged or floating plants form the third group. The submerged species do not require contact with the atmosphere. They have the ability to absorb carbon dioxide directly from the water and give off oxygen. Waterweeds, milfoil, and hornwort are among the submerged plants. Water hyacinth and duckweed float and survive on the surface without a root structure. Very fertile lakes often have large areas covered with this greenery, making fishing difficult.

All of these plants are vital to the production of oxygen, but excessive concentrations make fishing extremely difficult. Dead and decaying plant life also use up considerable oxygen when the decomposers do their job.

From a fishing standpoint, the littoral zone becomes a haven for bait as well as for predators. Small fish use shallow water and the abundance of vegetation for protection. This is also the area where the majority of logs and other types of cover are found. The food supply lingers in this part of the lake or pond and northern pike often wait in ambush among the weeds while bass will station themselves among this structure. Schools of bluegills also remain close to shore where they can feed and avoid predation.

Big fish frequently invade the littoral zone during periods of low light levels. Early morning and evening forays for food are commonplace and are usually the best times to fish the shallows for trophy fish.

Bottom—Benthic

The bottom of any body of water becomes a haven for a variety of organisms. Lake bottoms are divided into the littoral zone and the profundal, a deep water zone beyond the littoral. Although rooted plants are not considered part of the benthos, they may abound in the littoral part of a lake or pond. This area is characterized by a high oxygen content and low carbon dioxide.

The profundal represents the deep part of the lake and refers to waters usually found in the hypolimnion (below the thermocline) where light levels are weak, oxygen is low, and carbon dioxide relatively high.

Starting at the base of the food chain, decomposers are on the bottom and dead matter filters down. In nutrient-rich lakes, complete decomposition seldom occurs. It is important to remember that the process of decomposition uses oxygen and the area below the thermocline may have a minimum amount of this vital element during periods of the year.

Other animals hold near or on the bottom and feed on the decomposers. These include larval forms of insects (stoneflies and magflies, for example), several types of worms, and certain species of fish, (e.g.

darters). These animals are essential elements of the food chain. Larger predators attack the consumers and the food chain continues. The bottom holds a great many fish because it affords excellent hiding, a minimum of current, and more stable temperatures than the surface. In many cases, fish will hover just off the bottom.

To the fisherman, the type of bottom can be extremely important. Frequently, fish will stay on the edge where the bottom changes from sand to pebble, from mud to sand, and so forth. Any object on the bottom affords cover for a variety of animals. Rocks, logs, natural rises or pockets, and anything that sticks up from the bottom often appeal to fish.

As a general rule, the majority of fish in a lake or pond spend a significant part of the time in the lower 10 percent of the water column.

Rivers and Streams

The unique feature of rivers and streams is their constant unidirectional flow. No other type of water can make this claim. Flowing waters are constantly changing. The topography and the amount of rain and snow melt determine how much a river or stream fluctuates. Current can increase very quickly. Without a steady inflow of water upstream, levels begin to drop quite quickly. During drier times of the year, smaller streams and rivers break down into a series of pools. Riffles and rapids become gentle compared to their full potential. During major periods of flow, rushing water carries chunks of ice, logs, and rocks. These have a wrecking effect and often change portions of the river. At the same time, smaller particles are carried in a suspended state and is deposited in various areas as the flow changes, forming sandbars and other shallow areas.

Rapid transformations of water flow challenge the ability of various organisms to survive. The animals must adapt to fluctuating water levels and dramatic changes in current.

Shore Zones

The main force of a current is in the middle where water depth is the greatest. This changes when there is a relatively sharp bend. Here the primary force moves to the outside edge until the stream bed straightens again.

The area closest to the banks (except where a sharp bend occurs) has the least amount of current. That is an important factor in determining the types of flora and fauna inhabiting that area. This area might suddenly find itself high and dry when stream levels drop. Organisms that can swim or move about have no problem in this zone, but those that attach themselves to a stationary object are in trouble if the water level changes.

In areas where the water flow is reduced, aquatic vegetation often grows near the banks. However, each type of habitat serves as a haven for specific organisms that have a particular niche in which they survive.

Fishermen believe that most of the fish are in the deeper parts of moving water. That is not necessarily true. Trout, for example, may station themselves over a gravel bar close to shore where the typical fisherman enters the water. Fish, alert to unusual sights and sounds, flee long before the angler reaches the bank. It is precisely this type of experience that makes the enthusiast believe that all of the fish are in deeper and swifter water.

Bottom

The bottom habitat in flowing water changes more often than that in still water. Fluctuating flow conditions create currents that may cover certain areas with silt or other debris while simultaneously scouring out pockets, cleaning gravel bottoms and providing depressions and other hiding places for a variety of organisms.

In flowing water, there is less current near the bottom than at the surface or mid-depth. For this reason, most fish position themselves with their bellies almost touching the bottom. Any indentation or depression has even less current than the surrounding water. Organisms, including fish, take advantage of these spots to conserve energy. A very short distance away the current may be rushing, but in that little haven, life is comfortable.

Plankton does not usually exist in fast moving water but can be carried through such water from other sources. Lazier rivers and very slow sections of a stream may have some. Almost any tiny organism living in a stream has some form of appendage to hold it in place. The greatest problem for these miniature food sources is losing their grip on bottom structure and being swept away by the current.

Algae often grow attached to stones and rocks, and some rely on secretions or holdfast cells. One-celled algae, called "diatoms," form a coating on rocks, making them exceptionally slippery. That slickness reflects the bottom of the food chain. Snails use their feet to anchor to the rocks in order to feed on this algae.

Certain animals thrive near a current. The larvae of the caddisfly take advantage of the flow to filter out food particles. Mayflies require running water as do stoneflies, dobson flies, alder flies, and others. Animals live under rocks or they tenaciously cling to the surface.

The majority of fish in a stream face into the flow of water and wait for food to come to them. They are able to watch the water column from the bottom to the surface. It is not unusual to see a trout feast on a nymph (a bottom dwelling insect) one minute and on a floating insect the next.

Trout and salmon prefer cold, moving water and tend to take up stations where the flow is reduced but where they can move a foot or so to either side to take whatever food is coming by. During periods of low light and at night, these fish often invade the shallows where the current is reduced and where small fish may be holding.

It is important to understand that fish in current seldom move very far for food. An angler must present the bait or lure accurately or it will be carried downstream without a response. Fish feeding in a current have only a second or two to decide whether or not to take an offering.

Scientific observations have shown that most stream fish feed constantly and take advantage of whatever food filters their way. Specialization occurs only when there is an abundance of one type of food such as the hatch of a particular insect.

Riffle/Pool Concepts

As one moves up or down a stream, habitat changes constantly, varying from a series of riffles and/or rapids to smooth, fast flowing areas and pools. Water in riffles is well-oxygenated and often forms vertical currents as well as the standard horizontal flow. There is a tumbling action that affects life in that area. Usually rocks, logs, or other debris combined with a steeper gradient cause the riffle. Pools can also be well oxygenated and occur where there is a shallower gradient.

The severity of a riffle depends on the gradients and substrate and the seasonal flow of water or amount of rain upstream. In the spring, there is usually a strong flow, but by mid-summer, many riffles are a shadow of what they once were. Just above the riffle, the water is often relatively slow moving with a dead area caused by an area of little or no grade. Fish frequently hold in these locations.

Rainbow trout prefer locations near fast water and take up residence alongside riffles, but they are seldom in the main current. They can be found on the edges and down toward the tail of the run as it starts to smooth out.

The tail-end of a pool ranks high as a feeding area for fish because the water is somewhat slower and tends to flatten out. Depth decreases in this area due to siltation. Fish have a habit of holding at the tail of the pool and chasing whatever offerings come by.

A common misconception among trout fishermen is that their quarry moves into the tail of the pool during the evening hours. If one were to observe these fish undetected, it is possible that the trout have been there all day long. The problem lies in being able to approach the trout in this shallow area. They may detect the intruder and disappear before the first cast, leading people to believe they are only there early or late in the day. However, when light levels are low, it is easier to sneak up on the fish.

Estuaries

Estuaries are a mixing zone where fresh and salt water blend. At least one fresh water source enters the head of an estuary. A river may be tidal (influenced by tides) for several miles upstream, but is primarily fresh water. In an estuary, the closer to the ocean, the more marine the conditions become. As a rule, fresh or brackish water remains near the surface and the more saline water closer to the bottom. Tides tend to flush an estuary, bringing in sea water and carrying out some of the fresh water.

Salinity becomes the primary limiting factor affecting organisms living in an estuary. Fish and other mobile animals have the ability to work in and out with the tide and remain in water of relative constant salinity. That is not possible for organisms anchored in one spot. They must be able to withstand major changes in salinity. Some have the ability to pull back into their shells or to burrow as a protective device. The disadvantage is that they have a limited amount of time in which to feed while they wait for tolerable conditions.

Rivers carry suspended particles which usually drop once the flow slows in the estuary. The upper reaches of many estuaries feature a deep channel where the river cuts through with shallow flats on either side. Frequently, these flats have a soft bottom resulting from the buildup of sediment carried by the river.

Pollutants can be carried into an estuary and sewage and industrial wastes have caused changes in the typical flora and fauna. There, in shallow areas, oxygen depletion may occur from bacteria feeding on the sewage. This also limits the life that can exist.

Estuaries are fragile zones where changes can be very dramatic. Animals that require a reasonable amount of salinity do not go beyond a very pronounced, imaginary line. Fish that demand salt water limit their forays into the parts of the estuary that are less saline.

For the angler, an estuary offers exciting potential. Frequently, both fresh and salt water species take advantage of the mixing zone. It is here that the young of many species battle for survival and predators roam freely, simply because the food supply is present.

Finding fish requires one to check on the salinity, at least in a superficial way. Experience quickly teaches which fish venture farther into fresh water or remain in the salt. Looking for other forms of life serves as an important clue. The presence of barnacles, for example, indicates more salinity. Their absence shows that there is an abundance of fresh water.

A number of species spend most of their lives in salt water but ascend fresh water rivers to spawn. The striped bass, salmon, and shad are examples. These fish are said to be anadromous, meaning that they live in salt water but ascend fresh water rivers to spawn. Salinity is critical to the spawn and the eggs must be deposited where the right conditions exist.

Marshes and Wetlands

Tidal marshes and mangrove forests are critical to production of salt water game fish and forage species. Other wetlands serve the same function in fresh water. Juvenile fish seek shallow water where it is more difficult for predators to reach them, and certain species will move into shallow water to spawn. Deeper wetlands become a feeding ground for a variety of predators. Within these wetlands, the food chain flourishes on all levels and is vital to the survival of many species.

Marshes contain soft-stemmed, herbaceous plants known as "emergents" because they grow with part of their stems under water. Water depths may range from a few inches to about three feet. Among the plants found in a marsh are cattails, pickerelweed, water lilies, bladderworts and pondweeds.

By contrast, trees and shrubs dominate a swamp. These could be hardwoods or evergreens. Soils in both marshes and swamps are extremely organic with a black muck usually found on the bottom.

Many bogs are the result of retreating glaciers and have peat beneath them. They are most common in the northern tier of states, particularly the northeast and Great Lakes area. Peat results from the building up and eventual decay of plant matter.

Wetlands are among the richest lands anywhere in terms of production. A cattail marsh, for example, may yield 12 tons of biomass for every acre, while a sedge marsh produces about four tons. Some of this productivity can be traced to the fluctuations of water level. The fluctuations carry and expose nutrients and also insure adequate oxygen. Where periodic flooding occurs, the wetlands are richer than those with somewhat stagnant water. Saltwater wetlands benefit from the tidal cycle in much the same way.

Oceans

Almost three-quarters of the earth's surface is covered by oceans, and organisms living in the sea differ considerably from those in fresh water. Almost all ocean plant life is algae including the giant Pacific kelp and the acres of sargassum weed that coat the surface of tropical seas. Scientists report that algae, in one form or another, have not left any suitable habitat unoccupied. Phytoplankton require energy from the sun to reproduce and flourish. This occurs year around in the tropics but only during the summer months toward the poles. Complex groups of zooplankton live in the sea and the food chain progresses upward from there.

Fish are able to survive from the greatest depths in the ocean to the shallow, intertidal zone. Temperature and water depth limit the distribution of each species.

Intertidal Zone

The intertidal zone represents the interface between land and water. In the most common circumstances, the flooding tide covers an area. Then, that same zone is exposed to the air during the ebb tide. Complications occur during periods of spring tides when the water pushes farther shoreward or in areas where waves lap over an area, cover it with water and then fall back to the sea. Many life forms in this zone have the ability to burrow and survive. Some can no longer exist totally submerged or totally in air.

Salinity may also change in the shallowest parts of the intertidal zone, particularly after a rain or following fresh water incursion from rivers and streams. Bottom forms vary from rocky strata to sand and even mud. All serve various organisms. The food chain is elaborate and complex, with various species battling for space and a chance to colonize.

Game fish predators raid this prime habitat. The bonefish is a master at following the tide inland, feasting on crustacea and other animals coming out of their burrows as water floods the region. Big sharks prowl flats with their bellies scraping bottom and their dorsal fins and backs out of the water. Many other species of highly-prized fish also work the tides and look for food in the intertidal zone. Snook lie in depressions close to a sandy beach to ambush baitfish. These predators are constantly aware of water depth and know when to move seaward. On a shallow flat, one can actually see fish falling back into deeper channels just ahead of the receding water level.

Although all of these predators feel more comfortable in deeper water, they probe this shallow intertidal zone because it holds an abundance of food, including mussels, clams, and crabs.

Coastal Waters

Inshore waters are seldom as clear as the open ocean; therefore phytoplankton production is restricted to the uppermost levels. Production continues throughout the year in tropical locations, but may be seasonally limited in more frigid climes where the sun angle is exceptionally low during the winter.

Temperature also affects the variety of organisms in the water. The warmer the average water temperature, the more forms of life it supports. There are fewer species of animals in colder seas. One explanation is that tropical animals are more highly specialized and occupy a much narrower niche in the environment.

The coral reef is a phenomenon of the shallow, tropical sea. Reef-building corals cannot survive without a minimum water temperature of at least 68 degrees F. (20 degrees C.). The water must be relatively clear and less than about 300-feet in depth. There are other species of coral that grow much deeper, but they do not build reefs. The seaward side of a reef usually falls off into deep water rather quickly.

Ocean bottom may feature sections of exposed rock, but for the most part, it is composed of sediment or sand. Coarser grained sediments occur closer to land. The farther offshore, the finer the sediment. The size of sediment grains may seem inconsequential, but as part of the food chain, the larger the grain, the bigger the organisms that utilize it. It also means that burrowing animals must be of greater size.

Fish occupy all levels of inshore waters, with the largest number closest to the bottom. Pelagic species work the mid-depths and even the surface, moving wherever the bait happens to be. Coastal waters receive the heaviest fishing pressure, both recreationally and commercially. They are exceptionally rich in a variety of foods that support hundreds of species of game and food fish.

From the standpoint of adaptation, many species orient to some form of structure, such as a coral reef, rocks, or other obstructions along the bottom. Certain predators strike from ambush among the cover, while others roam freely, searching for an easy meal.

Depending on geographic location, anglers have dozens of species to pursue. The popularity of these inshore waters also stems from the fact that they are easy to reach aboard relatively small boats or from the beachfront.

One can almost predict the lifestyle of a species simply by looking at its physical characteristics. Fast swimmers that probe and prowl have forked tails and streamlined bodies. Those creatures that make their home in the rocks or around reefs are chunkier and have broad tails for maneuverability.

Open Ocean

The inland visitor who sees the ocean for the first time views it somewhat like a desert—a broad expanse that looks identical in every direction. Those who survive on deserts see marked differences in the terrain. Open ocean fishermen read the water with similar skill and understanding.

It is worth noting that every part of the sea explored by man has produced some form of life regardless of depth, water temperature, or amount of light. From a practical standpoint, however, anglers are only concerned with the top portion of the ocean.

Organisms as tiny as plankton occur in open water. Upwellings bring nutrient-rich waters to the surface where the sun causes more plankton to bloom. Zooplankton feed on the plankton and baitfish feed on them. These are a source of food for dolphins, tuna, marlins, swordfish, sharks, and other denizens of the deep.

The flying fish, for example, is an open water species of bait. Dolphin feast on flying fish and marlin attack small dolphin. Nothing is safe in big open water. Sargassum weed produces its own ecosystem. The tiny balls are really floats that keep this large algae on the surface. There is a sargassum crab that lives among the weed and several varieties of small fish seek sanctuary in that habitat.

Most fish species that live in deep water grow at a phenomenal rate, at least during the early years. A marlin grows from the size of a pinhead to 9 1/2 pounds in 12 weeks.

Recreational angling takes place within the confines of the continental shelf, out to about 200 miles. Researchers know that several species of game fish cross oceans, but the fishing pressure is limited to places that boats can reach with relative ease and safety.

Open water fishing is a specialty in which anglers seek prime game fish. To reach these fish, a large sportfishing boat, or at least one with a center-console with plenty of power to get out and back, must be utilized.

Countless species have evolved over eons of time and each shares the resource with others. To survive they specialize. Too much specialization might spell disaster, so each animal arrives at the right balance through evolution. The key lies in adaptation to the environment and ecosystem.

LESSON 24

Water as Environment

LESSON
24

Water as Environment

Lesson Objectives

Following this lesson students will:

1. Understand basic physical and chemical properties of water.
2. Understand the importance of water quality in sustaining fish populations.
3. Learn the basic relationships of fish populations to the water in which they live.
4. Be able to relate the various foods available for fish to the different types of water in which they are found.
5. Comprehend the steps in the water cycle.
6. Be able to discuss the thermal properties of water and density in relation to temperature.
7. Be aware of how human culture affects water in terms of use, pollution, and management.

Materials for the Lesson

1. Eye dropper, glass bowl, small piece of screen.
2. A length of string.
3. Two water glasses and several sugar cubes.
4. Pan, and a thermometer that can be used in boiling water.
5. Photocopies and overhead transparencies prepared from graphics in the appendix.
6. A chart showing the spectrum of colors, if possible.
7. Small container of dirt.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	The content of this lesson can be expanded to several class meetings and must be adjusted to meet the needs and abilities of your students. Be selective in the activities and demonstrations that you utilize based on these factors. Several resource people could also be utilized for selected topics on water use, pollution, etc. 1. Begin with a discussion of the importance of water in our everyday lives. Stress that it is a limited resource and for that reason we must be very careful. The demand for clean water is increasing. Ask students how water is important in their lives and then ask them how important it must be to fish. Water is, in a sense, their atmosphere and the quality of their environment will affect their ability to survive and prosper. 2. Two hydrogen atoms and one oxygen atom combine as a molecule to form water. Within a short temperature range, water can be a liquid, solid, or a gas. No other substance can do that within the span of 212 degrees F. or 100 degrees C.
II. The Nature of Water A. Physical and Chemical Features 1. Surface Tension	3. Ask students if they have seen items floating on the surface of water that seemingly should not be there. This introduces the concept of surface tension. Water has a very high surface tension and small organism often live on top of this film or just underneath it. This property can be demonstrated by using an eye dropper to show surface tension by allowing a drop of water to cling to the end. Also, this can be seen around the edges of a glass or in a bowl of water with a small piece of screen placed on top.
2. Capillarity	4. Capillarity is another physical property of water. This is the ability of a liquid to climb against the pull of gravity. Place a string in a bowl of water and drape the string over the side of the bowl. Shortly, the water will begin to drip onto the table. This property helps water to filter upward through the roots of plants.

Lesson Content Outline	Classroom Procedure
3. Density	5. Explain that similar to other liquids, water becomes denser as it cools. This continues until it reaches a temperature of 39.2 degrees F, where it is at its heaviest. Then, it begins to become less dense and lighter, and expands in the process. Therefore, water colder that 39.2 floats upward toward the surface, and as it freezes adds about nine percent to its volume, enabling ice to float. Illustrate by dropping an ice cube into a bowl of water and ask students if they have ever seen the result of water expanding as it freezes. Examples would be broken containers, etc. Explain that water is the only liquid that become lighter when it freezes. If it acted as other liquids, bodies of water would freeze from the bottom up, killing fish and other aquatic life.
	6. Following on the principle in #5, discuss what happens in the Spring when the ice melts. The water on top becomes warmer than the water on the bottom of the lake. As its temperature reaches above 39.2 degrees F., its become less dense and the cooler water from below moves to the top forcing the less dense top water to the bottom. This phenomenon, sometimes called "turn over" occurs both in the Spring and the Fall of the year.
4. Viscosity 5. Buoyancy	7. To demonstrate the viscosity of water (eg. thickness/thinness), if you are able to heat water, pour hot or near boiling water into a sink and then follow with cold water. Have the students note that the hot water splashed much more than the cold water. This property of water offers resistance to fish. However, there is a tradeoff. Bodies in water seem to grow lighter. A force equal to the weight of the displaced body buoys up the body. This same buoyancy principle permits boats to float. They displace more water weight that the weight of the boat and its contents. This property also permits fish to swim easily through the water.
6. Water Stratification	8. Emphasize that during the summer, between the Spring and Fall mixing periods, lakes and ponds form three distinct layers of water. A warm surface layer(epilimnion), a cold bottom layer(hypolimnion), and a middle layer known as the thermocline. The thermocline being the area of rapid temperature change. As oxygen is used up in the hypolimnion, fish tend to move toward the thermocline in the summer months.
B. Universal Solvent	9. Water can hold an incredible number of substances in solution and is often called a universal solvent. As it runs over the surface or trickles through the ground it dissolves some of these substances. Water does not change them, thus making them available to all types of aquatic organisms. In this absorption, water levels remain constant. To demonstrate this principle, take two glasses with the same water level. Into one, drop several cubes of sugar. Note that as they are absorbed by the water, the level does not change.
C. Transparency and Absorption of Color	10. Explain that water absorbs light. Even when water is clear, almost all light is filtered out within the first 30 feet. Ask students what this means for plant growth in clear or off-colored water. Where will it be found? Along with darkness, loss of color also occurs. Colors with longer wavelengths are absorbed more quickly and the red end of the spectrum disappears in less that 30-feet when the water is perfectly clear. Blues and greens are the slowest to be absorbed and can be seen the farthest. Flourescent colors retain their shades deeper than standard colors.

Lesson Content Outline	**Classroom Procedure**
II. The Water Cycle A. Natural Movements	11. Utilizing photocopied handouts and an overhead transparency, discuss the water cycle. Include here that water is a finite resource.
B. Impact of Human Culture 1. Water Use 2. Water Pollution 3. Water Management C. Our Water Inventory—Quality and Quantity	12. Utilizing the wall chart available from the Sport Fishing Institute, lead a discussion concerning water use, water pollution, and water management. Ask students for examples, both good and bad in your area, of the impact of human culture on water resources. Ask further, for them to suggest ideas that they could implement either individually or as a class to improve a particular situation in the local area. Stress that water quality affects our lives and will more so in the future and that we all have a responsibility to care for this scarce resource. As an example of human impact and as a result of construction or poor farming practice which allows erosion and runoff into streams, etc., take a bowl of water and pour in some of the silt or dirt. Mix it well and then pour this into another larger bowl of clear water. Notice how the silt permeates and spreads in the larger bowl. Expand the discussion to the affect that this can have on lakes, streams, and other bodies of local water.
III. How Water Affects All Aspects of Fish Populations A. Water Quality—Type of Fish and Quality of Populations	13. Discuss that fish enjoy and thrive in a good environment, just as people do. Where food is plentiful, the water quality is good, and cover exists, and fish populations will thrive. The opposite occurs in a poor environment. Lead a discussion about the local area and the fish that are available in certain types of water. Talk about why they are there, what would happen if the water quality changed, and what each student can do to preserve the water resource.
B. Water Color and Lure Selection	14. Discuss or have a resource person lead a discussion on how water color can affect choices in colors of lures. Talk about locally popular lures and colors and the types of fish caught on them. Color is a topic of much discussion and interest at the present time and many companies are producing lures to be utilized in waters of differing clarity. Formerly thought to be of less importance that other aspects of fishing, current research indicates that color may be more important that previously thought.
C. Water Type and Prevalent Foods	15. Fish are opportunity feeders, they generally take advantage of whatever is available. Discuss the prevalent types of forage available for the sport fish in your vicinity. Certain types of waters support different food sources. It is important to know these for your area and to determine what the forage species are when fishing unknown waters. Imitating these can provide good results for the angler.
D. Other Considerations	16. Different species of fish prefer differing water temperatures. Assuming adequate oxygen is available, water temperature is the most important factor in determining where fish will be. Slight temperature variations in a body of water will affect fish distribution. Look for areas that are a degree or two warmer in cool weather or a little cooler in warm weather.

INTRODUCTION

Most people take water for granted. It is as close as a faucet in the home or a nearby creek or canal. The casual observer comprehends very little about this vital ingredient of life. However, without water, nothing could continue to live.

For the angler, water represents the environment in which the angler's quarry must survive. The properties and features of this amazing liquid play a significant role in where fish are located and how they relate to their habitat.

Scientists report that water is totally recycled many times. None of it leaves the atmosphere and even the water humans drink was used many times before. Even so, that does not mean that water is evenly distributed across the earth, nor does it indicate that there won't be floods in one area and drought in another.

Knowledge of water density and how it leads to stratification of lakes is important to the angler as well as knowledge of the need for sound water management and the effects of pollution on an area rich in aquatic life. Water quality affects fish populations and individuals within the system. The condition of the water helps to determine the gamefish present and the available food sources. Being able to identify and understand changes in water quality and quantity is a valuable asset when trying to locate fish or select the best places to pursue a particular species.

NARRATIVE

The Nature of Water

Water covers 70 percent of the earth's surface with no substance being more common. Only three percent of the water is fresh, and about three-quarters of that is locked in glaciers and icecaps. In fact, these frozen regions contain as much fresh water right now as all of the earth's rivers will carry for the next 1,000 years.

The demand for clean water continues to mushroom as the earth's population increases and as industrial processes require more and more water. In the home alone, each person uses about 70 gallons of water daily for basic needs. This figure does not even include water required to produce food or used in industrial and manufacturing sectors of the economy.

Climate in many parts of the world is controlled by the slow heating and cooling of water areas. During the winter months, oceans bring moderating temperatures to land masses while cooling breezes are produced in the summer.

Recreationally, water lures countless people for swimming, boating, exploring the aquatic habitat, and, of course, fishing. Understanding water and its properties adds another dimension to angling and prepares the student of the sport to be a successful angler.

Physical and Chemical Features

Two hydrogen atoms and one oxygen atom combine as a molecule to form water. Within a relatively short temperature range, water can be a liquid, a solid, or a gas. No other substance can accomplish that within the span of 212 degrees F. or 100 degrees C. The molecules in ice are farther apart and practically motionless in comparison to the liquid state, where the molecules are much closer together and move about freely.

Surface tension is defined as the ability of a substance to stick to itself and pull itself together. Water has a very high surface tension that forms a film. Small organisms often live on top of this film or just underneath it. The tension can be so strong that if organisms break through in either direction, they cannot get back and will dry up or drown.

The ability of a liquid to climb against the pull of gravity is called "capillarity." This is an important property that helps water filter upward through roots and other objects.

Water can also dissolve other substances. In the process of absorption, water levels remain constant. This process dissolves particles from rock, soil, nutrients, chemicals, and other properties with which water comes into contact.

Thermal Properties

Heat capacity of a substance refers to the amount of heat required to produce a specific increase in temperature. With the exception of ammonia, water has a higher heat capacity than any other substance. During cooling, water gives up much more heat without a temperature drop than virtually any other substance. These thermal properties are extremely important and cause water to heat and cool more slowly than land or air.

Water freezes at 32 degrees F. (0 degrees C.) and boils at 212 degrees F. (100 degrees C.). Water is constantly losing molecules from its surface with these molecules becoming a water vapor. This process is called evaporation, and an incredible amount of heat must be absorbed without a temperature change before this is possible. When a pound of water is evaporated, it absorbs as much heat as it takes to raise the temperature of over 5 pounds of water from the freezing to the boiling point. In turning to ice, water at 0 degrees C. gives off 80 times as much heat as an equal quantity would in lowering its temperature one degree.

From an angling standpoint, heat capacity plays an important role. Water temperature rises very slowly in the spring and lowers over a long period in the fall of the year due to the property of heat absorption. Although air temperatures may be warm, the water in some areas may still be too cold for the fish species one seeks. Just the reverse could be true late in the season when air temperatures are chilly, but the water remains warm.

Density

Like other substances, the colder water gets, the more dense it becomes. This process continues until water reaches the temperature of 39.2 degrees F. (4 degrees C.) where it is at its heaviest, weighing 62.4 pounds per cubic foot. Then, a unique change takes place. Below that temperature, water begins to become less dense and lighter, expanding slightly in the process. Water colder than 39.2 degrees F. (4 degrees C.) floats upward toward the surface. As it freezes, it adds about nine percent to its volume, enabling ice to float.

If this phenomenon did not occur, ice would form on the bottom first and destroy aquatic life. There would not be enough heat in the summer to melt the ice and over a period of years, the whole water cycle would cease, as would life on earth.

Above 4 degrees C., water becomes less dense as its temperature increases. Cooler water is heavier and sinks to the bottom. Fluids transmit pressure equally in all directions. Any body completely submerged under water has equal pressure on all sides. In 100 feet of water, for example, there is about 58 pounds of pressure per square inch. Anything that lives at that depth must be able to withstand the pressure. Therefore, fish that move from bottom to surface and back must adjust to rapid pressure changes.

The fact that water becomes lighter and less dense just before it freezes plays an important role in deep northern lakes. As the warming rays of the spring sun melt the ice and begin to heat the surface water, a change takes place. When the surface water reaches 39.2 degrees F. (4 degrees C.), it begins to sink to the bottom aided by wind and currents. The cold water on the bottom is displaced and pushed toward the surface where it receives more oxygen. When this occurs, the lake is said to turn over. During that period of almost uniform temperature, fish may be found at any depth.

As the sun continues to warm the water, three distinct layers form in the lake. The warm surface layer is called the "epilimnion," while the colder bottom water is known as the "hypolimnion." Depending on its depth and the work of decomposers in the water and on the bottom, the hypolimnion may become depleted of oxygen and not support fish life. However, deep oligotrophic lakes rarely have a hypolimnion without oxygen.

Between these two layers, there is a narrow belt called the "thermocline." By definition, the thermocline exhibits rapid temperature changes of at least one-half a degree F. for each foot of depth.

In the fall, surface water begins to cool first and becomes denser, sinking to the bottom. That forces the bottom layer toward the surface until the temperatures become uniform. Then, the lake turns over a second time. This is a very important mixing process, helping to restore oxygen to areas that had a minimal supply.

Thermoclines also exist in salt water estuaries and in the ocean and often determine where fish will be. Usually pelagic species remain above it. One can locate a thermocline by taking temperature readings at various depths until a rapid change is noted.

Viscosity

Because water is viscous, it offers resistance to animals living in water that must be overcome through the expenditure of energy. A tradeoff occurs since a body placed in water seems to grow lighter. A force equal to the weight of the displaced water buoys up the body. This also allows a fish or aquatic animal to maintain buoyancy and counters the tendency to sink. Salt water is more buoyant than fresh water.

To the human eye, all water looks the same—a thin liquid that appears very viscous regardless of temperature. Actually, water does have changing viscosity and is twice as viscous at 32 degrees F. (0 degrees C.) than it is at 86 degrees F. (30 degrees C.). This can be demonstrated very simply by pouring a glass of ice water into a sink and then pouring some boiling water from a kettle into the sink. The boiling water will splash much more than the cold water, showing that the cold water is much more viscous.

Universal Solvent

Water does not dissolve everything, but it dissolves so many different compounds that it is often thought of as the closest thing to a universal solvent. It dissolves almost anything, at least to some degree, and holds an incredible number of substances in solution. Every time water runs over the surface or trickles through the ground, it dissolves some of the substances there. These are carried to oceans or inland lakes. Equally important, water does not change these substances which are vital to all forms of aquatic life, making them available to all types of organisms.

Transparency and Absorption of Color

Water clarity controls the quality of light that penetrates this liquid medium and the depth to which it penetrates. Even under extremely clear conditions, almost all light is filtered out within the first 30-feet. It is important to recognize that light is the essential ingredient in photosynthesis, explaining why plant growth is limited to relatively shallow water. Plankton and silt particles in many bodies of water cause turbidity, which limits light penetration. Under ideal conditions, one percent of the light can penetrate into the depths. One researcher estimates that in an exceptionally clear body of water, light can be detected as deep as 640 feet. A muddy river, however, may be totally dark only a few feet below the surface.

Darkness and loss of color increase with depth. The long wavelengths are absorbed more quickly and the red end of the spectrum disappears in less than 30 feet when the water is perfectly clear. That distance decreases with turbidity. Blues and greens have shorter wavelengths and are the slowest to be absorbed. Due to absorption of the long wave lengths of light, pigments (colors) appear differently at greater depths. The blues and greens are visible at much greater depths, while red objects appear black. Colors turn to a shade of gray and objects are seen in black and white, much as with the human eye during periods of very low visibility.

Fluorescent colors retain their shades even deeper than standard coloration. Orange, which is close to red in the spectrum, seems to retain its color much deeper, but certainly not as deep as the blues, greens, and even yellow.

Many species of fish require at least a minimal amount of light and tend to be disoriented in total darkness. No one really knows how much light is minimal, but experiments in large aquariums where total darkness was introduced by researchers demonstrated that some fish could not or would not tolerate the absence of light.

The Water Cycle

Oceans cover 70 percent of the earth's surface and become the primary factor in the water cycle. Heat from the sun causes water to evaporate and rise into the air as vapor. Every body of water gives off vapor, as do plants and crops through a process known as "transpiration." However, since the oceans are such vast repositories, most of the vapor comes from the sea.

Clouds form and air currents push these clouds. Eventually, precipitation in the form of rain or snow sends the water back to earth. Most of this falls on the oceans, with the remainder dropping on land. As the cycle repeats itself, all of the water returns to earth and none is lost. There is just as much water today as when the earth was formed, and there won't be any more in the future! However, new information indicates that enromous quantities of water are now entering our atmosphere from comet tails.

Natural Movements

When precipitation strikes the earth, some of it is transformed to vapor immediately through evaporation from the ground, rooftops, and puddles. A portion of the water enters creeks, brooks, streams, and rivers and eventually makes its way back to the ocean. The water absorbed by plants is returned through transpiration.

Water also seeps into the ground and moves very slowly under the surface until it reaches rivers or lakes. Some of it is channeled through springs. Underground springs release water of a relatively constant temperature that is often colder than the body of water it enters in the summer and warmer in the winter because it is at the temperature of the earth at the depth from which it came. This water often lacks the oxygen of the surrounding water, but it does provide more comfortable temperatures for fish. The area surrounding a spring should always be explored by the alert angler.

Impacts of Human Culture

Every living thing is primarily composed of water. A human and a mouse are each 65 percent water; the elephant and an ear of corn are about 70 percent. Water is vital in carrying out life processes. A person dies much sooner without water than without food.

Water use in the typical home has skyrocketed. It takes three gallons to flush a toilet, 30 to 40 gallons to take a bath, five gallons per minute in a shower, 10 gallons to wash dishes, and another 30 gallons in an automatic clothes washer. But, more than half of the water use in the United States can be traced to industry. It takes 10 gallons to make a single gallon of gasoline or beer, but 250 tons of water to make a ton of newspaper. In addition, enormous quantities are utilized in food production, especially in areas where irrigation is prevalent.

There are adequate supplies of water to handle these needs provided sources of the precious commodity are kept clean. However, some states in the Southwest must import water from others. Unfortunately, pollution taints some of the very rivers and lakes that might furnish the needed waters for expanding populations and industrial demands. As an example, 8 billion gallons of fresh water flow past the City of New York every day as the Hudson River empties into the sea. That is enough to supply 40 million people with 200 gallons a day if it could be used. However, the river is too polluted with toxic chemicals to be used as a water supply.

In most communities, sewage contamination is the major cause of pollution. Untreated or partially treated sewage is dumped into a potential water supply. That sewage contains bacteria and viruses that could cause serious diseases in humans. Sewage also contains nutrients such as phosphorous and nitrogen that serve as fertilizers. As these substances enter a water system, they cause algae to bloom in uncontrollable quantities. When these organisms die, the decomposition can deplete the oxygen, thus killing fish. More oxygen is lost and the process of eutrophication or overfertilization may cause most life in that water to cease. Runoffs from farmlands also cause similar problems because they put excessive quantities of nutrients into the system.

Silt carried from the land creates a different type of pollution that tends to reduce light penetration and photosynthesis. As silt falls to the bottom and begins to fill the lake/reservoir basin, it covers the delicate organisms living there and often destroys the eggs of fish in the process.

Toxic wastes from industry and agriculture have been a serious problem for a long time. Many of these kill fish directly and also affect the supply of oxygen in a body of water. Steps are being taken in some places to reduce and eliminate toxic wastes, but they are still a major cause of pollution in many areas. Also, some industries create a situation leading to acid rain which causes serious water problems.

Oil pollution through spills and thermal pollution through the discharges of power plants, particularly the nuclear ones, occurs. Pesticides also enter the water and often act directly, killing the eggs, fry, or juvenile stages of fish.

To counter this, many bodies of water are now being managed and efforts are being expended to eliminate sources of pollution. Those waters that are not being managed properly now probably will be safe-guarded in the near future. Dams and flooding create new reservoirs as sources of water and as recreational areas where fishing, boating, and other water sports can be enjoyed. One cannot dump wastes in water, then expect to drink that water or to play in it. The key lies in controlling pollution. The more successful this nation is at that task, the better the water will be for a multitude of uses, including fishing. If pollution is not deterred, citizens could end up with inadequate supplies for basic needs.

Our Water Inventory—Quality and Quantity

There will not be any more water than there is today, so quantity really applies to quality. One has to ask whether or not there will be enough quality water to take care of everyone's needs. The restoration of Lake Erie from a polluted lake to one that is becoming progressively cleaner is testimony that water quality can be improved through careful management.

When all the rhetoric on the subject has been exhausted, the bottom line still points to the need for quality water at any cost. For gamefish to survive and thrive, the water quality must be fairly good. Fish are barometers of the condition of water. When they cannot survive, the water is not fit for human use.

How Water Affects All Aspects of Fish Populations

When dealing with populations, one must view the ecosystem in its entirety. Each species of fish occupies its own niche in the water environment. However, there is an interdependence among species that must not be ignored. If water conditions change and are no longer conducive to the production of forage species, game fish which rely on that food source will suffer. Their numbers may diminish and their growth may become stunted or at least slowed.

Natural events also force temporary changes in water conditions. During a summer drought when hot weather evaporates water at a much faster rate, a stream's flow may taper off, causing a reduction in water movement. Fish must either adapt to the new environment or change location. Spring floods might come at a time when a species is in the midst of its spawn, resulting in the eggs being washed away or destroyed. Additionally, the entry of toxic chemicals into the water will have an immediate and disastrous effect on fish populations. Each ecosystem is fragile and the balance of nature often becomes a precarious one. Natural and human activities and events can wipe out a year class of fish or trigger undue stress on the population.

Water Purity—Type of Fish and Quality of Fish Populations

Harsh environments such as the arctic, deserts, jungle, and high mountains support a minimum of human life. Finding food in these extreme regions is difficult and survival is very taxing. The handful of people who live in those places often die young and are seldom the best physical specimens. More temperate and tolerant climates become home to the largest populations, where growth can be achieved with reasonable ease.

It is no different beneath the surface of the water. Healthy water environments support the strongest populations of fish and some of the largest specimens. Introduce pollution, the encroachment of human habitation, or destruction of critical habitat, and water quality suffers. This, in turn, reduces the population of fish present and frequently the size of the individual members.

When changes are introduced into a waterway, the carrying capacity may be reduced very quickly. Minor variations often make the difference. Fish are extremely sensitive animals that seldom adapt well to rapid change. They require adequate amounts of oxygen and very specific water temperatures. Water quality becomes the key to their growth and proliferation. Turbidity has to be considered a limiting factor because it disrupts the food chain and makes feeding more difficult.

In a marine environment, there are other factors that must be considered. Salinity content can be extremely important, particularly in estuaries and inshore ocean waters. Excessive amount of fresh water feeding into these areas from rivers, canals, and water management areas can easily upset the balance.

Currents in an ocean can make a difference. Their edges are usually extremely rich places because nutrients from the deep surface arrive there through a process known as upwelling. Although the ocean may look uniform across the top, the water is really very different from place to place. Pelagic species of fish are constantly on the move, searching for food supplies and favorable water conditions.

Water Color and Lure Selection

In recent years, a growing number of bass fishermen have started using electronic gauges that measure water clarity, much as a Secchi disc.The readings from these instruments can be interpreted on a chart that suggests certain lure colors. Basically, the idea is to rely on lure colors that can be seen under the specific conditions determined by the meter. Whether or not this becomes an accepted practice remains to be seen.

Long before bass fishermen began using these gauges, serious anglers developed their own theories about water color and lure selection. It applies across the board to all types of fishing situations. Primarily, anglers use darker colors in dingy or turbid water and prefer lighter shades when the water is clear. In murky water, black can be an excellent color. It also works well moved along the bottom. Those who use heavy jigs in salt water to probe the bottom or work the various levels in the water column rely on white as the first choice and yellow as the second.

When a fish looks at an offering that is being worked across the surface, color becomes very deceptive. The animal really sees a silhouette which is either dark or light. The perspective changes if a fish moves up behind the lure and views it horizontally at closer range.

Anglers recognize that colors fade with depth, but they also disappear with horizontal distance. If reds are not distinguishable in 20 feet of depth, they are also not distinguishable horizontally when they are 20 feet away.

There is a tendency to oversimplify the theories on colors underwater. How they are perceived often depends on the angle at which they are seen and the background against which they are shown. A simple gauge or chart does not account for the variety of underwater conditions.

Some of the most abundant species of baitfish are silver in color and often nearly transparent if very small. The silver is actually a form of camouflage because it reflects the surroundings. However, predators still manage to locate and capture their prey. Fluorescent colored lures certainly stand out, but whether or not a predator will attack something with unnatural coloration is well known. Enough gamefish are caught on lures of every color to convince most people that a predator might simply strike the movement rather than the color.

Leading anglers rate lure color a low priority when selecting a lure, believing that approach, presentation, and retrieve are far more important than the shade of the bait. These anglers are not overly sensitive and may start fishing with a dark shaded bait. If that doesn't work, they will change to something light in color. They seldom are fussy about particular hues, but will try to make major variations from dark to light or vice versa. Recent research, however, indicates that lure color may be more important than previously thought, and many companies are producing lures with colors identified by an electronic unit as superior for use in specific water.

Water Type and Prevalent Foods

With few exceptions, most fish are opportunity feeders. However, certain fish have some things they will not eat under any circumstances. For example, muskies rarely feed on perch, even if they are abundant. They may have a specific preference if given a choice, but they do take advantage of whatever happens to be available. When there is an abundance of a certain food, such as a major insect hatch on a particular trout stream, the fish tend to specialize. Specialization helps them achieve feeding efficiency, which expends less energy than simply feeding at random.

Smaller stream trout are primarily drift feeders. They maintain a lie and wait for the current to carry food to them. This may be in the form of nymphs on the bottom, aquatic insects at any level, or insects on the surface. These fish will also eat minnows and other small fish if given an opportunity. They will also take worms, grubs, crayfish, and anything else they can find.

When the water is not flowing, the trout must move around within a limited area and search for food. This happens in many limestone streams where plants under the surface harbor a population of insects and other small things. The same species in a lake or pond may also have to prowl for its food.

Bass may be ambush feeders at times, waiting for whatever happens to come by. The same bass searching for food, may school over some structure or may swim slowly scouting for a meal. These differences in behavior and food preferences help the fish to survive under a variety of conditions.

When a body of water hosts large schools of baitfish, most predators will use that situation to their advantage. The abundant alewives in the Great Lakes, for example, become a primary food source for salmon and large trout. The predators tend to follow the schools of bait and feed heavily.

It is always an excellent idea when fishing unknown waters to find out the primary forage species. Use or imitate the same species for bait and the results should be impressive.

Finding food in a marine environment is not any easier. Fish search for schools of bait and shadow this source of food, feeding when the urge strikes. The target could be menhaden, mullet, pilchards, herring, sandeels, or any other abundant species. When they cannot find food, most gamefish roam looking for whatever they happen upon. However, stomach samples from fish typically indicate a variety of food with a dominant item.

The most important factor lies in finding bodies of water and specific areas that support a strong food chain. When the forage is there, predators will find it sooner or later.

Other Important Considerations

Water temperature deserves even more emphasis than it has received. Assuming there is adequate oxygen, water temperature is the most important factor in determining where fish will be. Trout must have much colder water than bass or bluegills. Many warmer streams hold smallmouths, bluegills, and other species, but the water simply is not cold enough for trout. Generally when trout are present, largemouth bass will be somewhere else because the water is too cold.

Temperature tolerances limit the distribution of various fish. Walleyes are not readily abundant along the southern tier of states because the water is too warm. Fish the north country and walleyes, along with perch and muskies, are mainstays of the population.

Even within a given body of water, slight temperature variations will affect the distribution of fish. Look for areas that are a degree or two warmer in cool weather or a little chillier in warm weather. Fish are extremely sensitive to even minor temperature variations and respond to these differences.

Along the ocean fronts, certain species are present during a specific time of the year. They don't arrive until the water temperature is tolerable. When that temperature begins to change dramatically, they are gone. In many cases, no one really knows where the fish go other than that they disappear.

Sometimes, pockets of cold water along the coast will keep a species from migrating northward temporarily and delay the arrival in a particular area even if that water is already within the tolerances. A great deal more is becoming known about ocean temperatures including satellite data showing where warm water and cold water gyres break off major ocean currents. Temperature is critical and certainly worthy of every angler's attention on a continuing basis.

UNIT IV

WATER RESOURCES FOR OUR FUTURE

LESSON 25

Aquatic Information and Management

LESSON
25

Aquatic Information and Management

Lesson Objectives

Following this lesson students will:

1. Understand the major effects that human activities have had on fish resources.
2. Recognize forms of pollution and encroachment.
3. Know how increased fishing pressure and use of the waters affects fish and fishing.
4. Be able to discuss bag and size limits, seasons, and other management techniques for increasing fishing potential and distributing the catch.
5. Know what is meant by "exotic species" and the effects they can produce.
6. Have some insight into the conflict between commercial and recreational anglers.

Materials for the Lesson

1. Overhead transparencies and photocopies of the graphics from the appendix.
2. Materials from local or national conservation organizations that concentrate on the topic of this lesson.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
	This lesson has the potential for you to utilize one or more guest speakers. A fisheries biologist or biology teacher, the local conservation officer, a commercial fisherman, a building contractor, a manager from a large manufacturing facility, and others all have potential to contribute to the content of this lesson. If you have major problems in your local area and a class of older students, this lesson could be expanded to several sessions. 1. Introduce class to the lesson objectives.
I. Effect of Human Activity A. Habitat Degradation 1. Encroachment 2. Pollution a. acid rain b. toxics c. runoff B. Management of Fragile Systems	2. Lead an initial discussion that can center on the following topics: A. Humans being attracted to water B. Volume of waste, its treatment, and effect on water. C. Growth in fishing pressure D. Effect of industrial, housing, and other developments. E. All deal with encroachment—and habitat degradation—discuss these terms, what they mean, and identify local examples. 3. Discuss pollution in all of its many forms including littering, the burning of fossil fuels (acid rain), waste disposal—industrial, human, toxic, etc. and the major problems these cause to aquatic resources. Include the use of pesticides, insecticides, and fertilizers on farmland. 4. Discuss why management of fragile aquatic systems is a major issue today and what steps are being taken to improve previously polluted water—the Great Lakes are a good example to use here.
II. Fishing Pressure A. More Anglers, More Sophistication B. Limits C. Seasons	5. Discuss the large number of anglers today and their increasing sophistication. How does this affect the resource? What can each person do to help. 6. Discuss the role of size and bag limits, slot limits, fishing seasons and the role of effective enforcement of game and fish laws. What can we do as individuals in addition to following these regulations ourselves? What would happen if they didn't exist and/or weren't enforced?

Lesson Content Outline	Classroom Procedure
III. **Endangered Species** IV. **Exotic Species**	7. Discuss the role of management to avoid endangered species and what effect the introduction of an exotic species can have on the aquatic environment, including other native species of fish.
V. **Commercial/Recreational Conflicts**	8. The conflict between commerical and sport fishermen occurs mostly in salt water areas and in the Great Lakes. In these areas, heated arguments have occurred over the resource and its use and/or misuse. Native Americans, with the historic right through treaties to fish, have been embroiled in some of these conflicts. Students should know why this occurs and what has been done.

INTRODUCTION

Nothing can enter an environment without changing it. Alterations may be inconsequential and hardly noticeable or of major or even catastrophic proportions. In the case of water resources, the effect of human activities has been dramatic. In the early development of this country, settlements began on the banks of rivers and lakes, estuaries and oceans. To this day, homesites along any waterway—natural or manmade—are sold at a premium. The expansion of transportation systems, superior highway networks, and human preferences have caused an influx of people to seek this habitat and, in the process, sometimes have destroyed what they came to enjoy.

Today's civilization creates wastes faster than they can be treated, resulting in an adverse effect on all types of water. Fish resources suffer from poisons and other "cancers" in the system. At the same time, the working habits of people continue to change with increased leisure time and a shorter work week. Predictably, fishing continues to reign as one of the most popular pastimes, with millions taking to the waterways.

As pressure increases on the habitat and the resource, solutions must come from aquatic research and successful management. Conflicts mushroom among user groups. Some species have been threatened with extinction. There are those who believe that the introduction of exotics may provide the answer, but that can be an approach filled with danger for native species.

The student of angling cannot live in a vacuum, concerned only with the immediate gratification of catching fish. The angler must be totally aware of the situation as it exists today and the prognosis for the future. Quality fishing tomorrow centers on sound management practices now.

NARRATIVE

The Effect of Human Activities on Fish Resources

Man has always gravitated to water. In one sense, it is the essence of life and absolutely vital to survival. Equally important to the early settlers, waterways formed the original transportation network of this great land. Villages and towns were built in strategic places to take advantages of waterborne commerce. Farmers and ranchers relied on the flow of this critical commodity. During the industrial revolution, water became a source of power and a necessary ingredient in the manufacturing process. Today, huge quantities of water are utilized in manufacturing processes.

In Colonial days the supply of fresh water and the bounty of the oceans seemed endless. An untapped inventory of new territory and untouched sources of water lay just over the horizon. Through the years, few people expressed concern as the fish resources in river after river disappeared. Along the East Coast, runs of Atlantic salmon disappeared from many rivers. Shad no longer journeyed upriver. Populations of trout dwindled as pollution destroyed the clear, pristine waters so necessary to their survival.

Most folks were too busy earning a living to care. Who could have battled giant companies that dumped wastes in streams or taken on municipalities who used flowing water to wash away their sewerage. It has been said that a conservationist is someone who lives downstream from a polluter. However, America was not ready to do anything about the loss of resources. For one thing, the knowledge of what was happening was never broadly disseminated. Leisure time was a luxury and fishing was often a method of bringing home food rather than a source of relaxation and pleasure. If a lake or river did not yield enough fish, it was easy enough to go somewhere else. Angling pressure was not a major concern.

Farsighted scientists and conservationists pointed out that human encroachment and disregard for waterways were destroying fishery resources. Further research dictated the need to develop techniques for managing fish and water. Hatcheries were started in an effort to replace dwindling fish populations. Efforts often fell short because managers, politicians, and anglers did not fully understand that the habitat had to be improved before stocking would be effective.

Originally, catches were limited by establishing seasons and only allowing fishing during part of the year. At the same time, bag limits were set so that each person could only catch so many fish per day. Then, size limits came. The theory was that small fish should be returned to the water until they grew and possibly spawned at least once. Fisheries management today is a much more exact science than it was then, but those first efforts were necessary to make people aware of the problems. Now, dedicated scientists are trying to salvage what is left and improve conditions through newly developed techniques and understanding.

Habitat Degradation

No part of the United States has been totally immune to habitat degradation. In the Pacific Northwest, as well as the Southeast, lumbering has had an adverse effect on water resources and fish populations. Timber harvesters in Oregon and Washington rely on the rivers in their work, leaving debris and trees that often alter the natural flow of streams. Clearcutting and overharvesting make it easy for rain waters to carry silt and dirt downhill to the nearest river, changing the clarity of normally clear streams. Silt damages the production of plant life and can destroy the eggs of sensitive species such as salmon and trout.

Logging in Maine and other New England states produced similar problems for streams and rivers. Although the ultimate concern of the angler focuses on the water and fish resources, land use is often the source of the problem. Without proper management of an entire watershed, individual creeks and rivers suffer.

Hardwood swamps once covered a substantial portion of southeast bottomlands. Many of these remained flooded for most of the year with fish populations relying on the abundance of dead organic material and the production of green plants in these areas. Unfortunately, to make logging easier, many of these swamps were drained. In the Mississippi River plain, for example, only one-fifth of the original 24 million acres of habitat remains. Clear-cutting of trees and draining through channelization were the culprits. Supposedly unproductive swampland has been turned into farms where cotton and corn became staple crops, followed by soybeans. At a time when agricultural interests are paid *not* to grow certain crops because of an overabundance, valuable habitat has been lost forever.

In the name of flood control, many areas pockmarked with canals and meandering rivers have been "straightened" through channelization, a process that destroys precious habitat and fish resources. The famed Florida Everglades have been victimized by this process in which water flow is controlled artificially by man. This "river" of grass harbors a unique ecosytem that relies on the natural flow of fresh water from the center of Florida to Florida Bay. Not only have fresh water species been affected by this attempt to prevent flooding, but also the mixing of fresh and salt water in the estuaries has been changed. This has had a debilitating effect on many salt water species that rely on these nursery grounds for production of their young.

Without the steady flow of fresh water, high salinities occur further inland, destroying organisms that are not salt-tolerant. It is a fragile system in which even minor changes signal serious results. Such playing with nature is a dangerous game with broad consequences.

Encroachment

About two-thirds of the marine species rely on estuaries for survival during a portion of their lives. Even those that remain in deep water often feed on fish that require an estuary. When the Pilgrims stepped ashore at Plymouth Rock, the coasts of this country provided unpolluted habitat in the form of plant life, free flowing water, and a natural environment that fostered the population growth of salt water species.

From that time, the inventory of this precious habitat began to decline. It has continued to diminish steadily, but in recent years, the demise of this productive zone has occurred at an alarming rate. Pollution is one factor, but dredging, filling, bulkheading, and other construction projects have created serious conditions. Frequently, dredging has been done to recover sand and shells for other purposes. Developers fill in wetlands to build residential complexes on the shores of water. Bulkheading has destroyed the natural flow of water and eliminated certain trees and plants critical to fish production. No example is more vivid than the destruction of mangroves with their tangled roots that not only help to filter the water, but also provide a haven for countless species of juvenile fish.

People enjoy living on the shores of lakes and rivers. As a result, lakefront property brings premium prices. Cabins and cottages now encircle impoundments and lakes that were once natural and untouched. Even streams entice families to seek solace on their shores and build either permanent or summer residences. The simple fact that humans reside at the water's edge spells "encroachment" in capital letters. Trees and plants are cut for a better view. Docks and bulkheading often replace the natural shoreline and the resulting environmental changes are seldom for the better.

Those who are fortunate enough to live near the water are not about to give it up. One can surmise that even more people will move to these surroundings if the opportunity is there. Right now, the task is to limit construction and to insure that critical habitats are preserved in their natural state if recreational fishing is to continue. The draining of wetlands and swamps and the building of edifices may improve the tax structure of a community, but it destroys extremely valuable habitat.

Pollution

Pollution is a natural adjunct of human habitation. Indiscriminately discarding unwanted items is a basic form of pollution. Littering not only destroys the beauty of our aquatic resources, but also can harm fish. Cases of small fish becoming caught in discarded pop tops from cans and larger fish being gilled on the plastic holders for six-packs of soft drinks have occurred. Everyone can do something about this problem litter by eliminating and encouraging others to carry out all items brought into an aquatic environment. According to most experts, this is a serious problem, but relatively speaking, less serious than the damage from acid rain, toxics, and even runoffs from farms.

When fossil fuels are burned, sulfur dioxide and nitrogen oxides are given off as byproducts and enter the atmosphere through smokestacks or from the tailpipes of automobiles. When these emissions mix with water vapor in the air, they form acids that eventually find their way back to earth in the form of rain, snow, sleet, dew, and even as dry particles. The term "acid rain" describes such precipitation that has a particularly high acid content.

Acidity is measured on a scale of 0 to 14. The lower the number, the more acidic the solution. A pH of 7.0 is considered neutral and is neither acidic nor alkaline. Natural rain is slightly acidic because carbon dioxide and water in the atmosphere have a pH of 5.6. Any pH below that number indicates the presence of acid rain.

Acid rain is a worldwide problem because it is carried aloft for great distances before returning to earth. Electric utilities create a significant percentage of these emissions, but other manufacturing processes also do their share. Of course, automobiles add to the problem. As a result thousands of lakes in the United States, Canada, and other countries have been victimized by acid rain, an extremely debilitating form of pollution causing multiple reactions.

Increased acidity in a lake or stream may attack the reproductive systems of fish and can kill or deform the fry, which are often more vulnerable than the eggs. Acid rain also plays havoc with the food chain and destroys plants, plankton, and other organisms that provide food for baitfish. The acid may also weaken bones of fish and cause metal poisoning resulting in fish kills. Metal poisoning can occur when the acidic water helps to dissolve certain metals such as aluminum and hold them in solution.

Within the next 15 years, countless lakes and miles of streams may be lost permanently to acid rain if drastic steps are not immediately taken to reduce sulphur dioxide and nitrogen oxide emissions. It must be remembered that acid rain has far reaching effects. Pollution in one area can be carried hundreds or even thousands of miles and dropped in places that have not seen a smokestack or automobile. The lakes most affected are usually clear lakes in granite or sandstone basins. Fortunately, lakes in limestone areas, our most productive lakes, are less affected.

Waste Disposal

Waste disposal becomes an ever-increasing problem in most nations of the world. One of the primary reasons that industry locates on a waterway is to facilitate waste disposal. Whatever the byproduct and no matter how toxic the effluent, disposal is simply a matter of pumping waste overboard and letting the water carry it away, regardless of consequences. It doesn't take a sophisticated scientist to know that cyanide, sulphide wastes, acids, and other chemicals make it difficult for most organisms to survive.

Metals in solution are often incorporated into deadly wastes. Fish have trouble surviving lead at 0.3 parts per million or copper and zinc at 0.5 ppm. Gills and mucous membranes become damaged by metals and the fish suffocate. Ammonia and chlorine cause congestion of membranes and nervous spasms. Fluorine results in death through a nervous disorder. PCB's, mercury, and dioxin are also common toxic contaminants. These contaminants persist for a long time in aquatic systems, accumulate in fish, and can be hazardous to humans who ingest them.

When major fish kills are reported through the news media, people shake their heads and then forget about the tragedy within a day or two. Industrial wastes (runoff) and municipal sewage are the primary culprits. The toxic conditions need exist for only a few minutes to destroy a stream. Even in the few cases when a company must make restitution for damage to fish stocks, it is a pittance compared to the long term loss of the resource.

Farming today goes beyond putting seeds or small plants into the ground and hoping they will grow. It is a sophisticated process in which nutrients are added to aid growth and pesticides are applied to reduce or eliminate damage by insects. Crops may blossom because of this increased care, but the process also pollutes nearby lakes, streams, and rivers. Ground water as well as rainwater and snowmelt runoff carry both the nutrients and the pesticides into these waterways. The pesticides are poisonous and have an immediate and disastrous effect on various fish species. Excessive nutrients work a bit more slowly, but are also deadly.

The introduction of nutrients causes green plants to grow faster. Populations of algae and other microorganisms expand rapidly into dense populations called "blooms." In the process of eutrophication (also caused by untreated or partially treated sewerage), there are not enough consumers to eat the producers. Increasing quantities die and the decomposers go to work. This depletes the oxygen and causes stress on gamefish, often resulting in fish kills or at least in forced migration.

Management of Fragile Systems

The days of nature maintaining water systems and totally providing for fish resources have lapsed into history. These fragile environments have lost their cushion and are now dependent on man for proper management and control. Basically, man has caused the problem and is now having to find the solution. The answers are slow in coming and equally difficult to administer.

Major sources of pollution must be stopped if fisheries are to exist. Even when massive fish kills do not occur, damaging the water reduces the carrying capacity at all levels of the pyramid. Acid rain, toxic wastes, and runoffs of nutrients and pesticides have a frightening finality.

Hatcheries can only do so much toward replenishing fish stocks. To maintain adequate fish stocks, there must be natural spawn and natural growth. The put-and-take fisheries that occur with hatchery trout are a management measure. They are successful because they are the "only game in town." Anglers may prefer native trout, but hatchery fish that have been in the "wiids" for a few weeks are usually indistinguishable from natives.

Even the oceans and estuaries of the world are fragile ecosystems that require attention and monitoring. For the first time, people are learning that the oceans are not endless wells with unlimited resources. Instead, they are capable of very finite production that depends on water quality and favorable conditions. Chesapeake Bay is a case in point. Formerly a tremendous source of striped bass and oysters, the ecosystem has been polluted to the point of severely diminishing these populations. However, aquatic ecosystems have shown that they can be resilent. Many bodies of water have been restored to excellent fisheries, the Great Lakes being a good example.

Fishing Pressure

Fishing pressure has increased significantly. Not only have more people taken up the recreational pursuits of fishing, but also they have more time in which to enjoy their hobby.

Statisticians report that more than 60,000,000 Americans fish. Fishing ranks high on the list of recreational activities and continues to grow in popularity. Satisfying this desire in the populace is another matter. Management of the resource becomes extremely important, particularly in areas close to major population centers. Even remote regions bear careful watching. Float planes and spike camps make these areas relatively easy to reach. No area, from the Arctic to the Amazon, is remote enough to discourage fishermen from testing the waters.

With masses of anglers pursuing every species imaginable, solitude on the water has become much more elusive. The days when one can fish all day without seeing another person are the exception rather than the rule. Increased pressure by anglers, whether afoot or aboard a boat, often forces fish to change their feeding habits or migratory routes. It is difficult for a fish to feed when people are tramping through their habitat from daybreak to dark. Regrettably, there are areas where shallow water species no longer invade in great numbers because boat traffic has increased to the point of becoming frightening. Even veteran bass anglers consider different fishing techniques on the weekends than during the week because the fish have been pushed further back into cover with more anglers and other recreational users on the water.

More Anglers, More Sophistication

Not only has the number of anglers increased, but also the typical fisherman today is much more sophisticated. The reasons are twofold: technological advancements in equipment and techniques plus improvements in the dissemination of information. Casting has been made easier with rods made from Space Age materials and reels that boast extensive features. Lures span a wide range, including an arsenal of soft plastics and special scents which can be applied to remove human odor or to entice fish.

Small boats contain sophisticated electronics, including depth sounders which paint a picture of everything below the bottom, trace it on graph paper, or show it via a liquid crystal display. Loran C represents a sophisticated navigation device that puts the angler within 100 feet of a target in large bodies of water. Water temperature is monitored electronically and pH and oxygen meters can tell the condition of the water. Water clarity gauges relay information on turbidity and suggest the best color lures for the water conditions. Two-way radio communication puts anglers in touch with one another so that those who do not find the fish can be directed to the best areas.

The boats, themselves, are sophisticated fishing platforms. Not only do they house the electronic gadgetry, but also they are fast, sea worthy, and tailored to do a specific job. The introduction of the center console boat for marine use changed the entire character of the offshore fishery, opening it to people of moderate means. Prior to the advent of that boat design, only wealthy people could afford repeated trips to blue water. The center console brought that type of fishing within reach of average income anglers.

The media expanded its contribution as more magazines and periodicals have appeared on the scene and focus on the how-to and where-to of fishing, leaving general interest stories to the major publications. Newspapers expanded their coverage and radio became another vehicle to tell people where, when, and how to fish. At the same time, television stations hired fishing reporters to cover the local area.

National and regional television programs illustrating techniques have grown in their appeal, each one imparting knowledge to the average angler, only visually. From that stage, the process shifted to video tapes centering on the how-to aspects. The angler can now learn to fly cast, tie knots, make rods, catch bass and trout, and do a hundred other things while sitting comfortably in a den or living room watching an expert perform. All of this has helped to lure more anglers to the sport and to make them more sophisticated.

In many parts of the country, fishing courses aimed toward a technique or species are commonplace, usually taught by a local expert. The continuing education division of at least one major university makes its staff available each year to teach fishing techniques. If an angler wants to improve, he has more options today than ever before.

Limits

Size limits and bag limits are two tools of fisheries' managers to protect the spawning stock and to make sure that the population can renew itself. In cases such as trout, where rough handling can destroy small fish being released, managers often eliminate size limits and establish bag limits. At times, however, there are upper level size limits preventing taking more than one fish over a certain size. This is particularly effective where the larger fish are the primary spawners. The theory is to allow one trophy, but prohibit anglers from keeping most of the spawning fish.

Changing size or bag limits sometimes has a measureable effect on the fishery. The key, of course, lies in enforcement. If these laws are not enforced, the results leave much to be desired. Most fresh water species are managed with bag limits, but the practice in salt water is limited. Even so, there is a growing movement to assign size and bag limits on oceans and estuaries. Certain species such as dolphin, bluefish, flounder, and others have not been managed. Anglers tend to keep and kill more than they need, sometimes selling the excess to pay for fuel and other angling costs.

These people reason that there are millions of these species in the ocean and that their catch is negligible when compared to the total. What they fail to see is the cumulative catch. By releasing unneeded fish or adhering to a limit, more of the species may be saved to spawn.

Seasons

Closed seasons are another management tool to help maintain specific fish populations at renewable levels. This may be done to simply relieve pressure during part of the year or may be targeted to the spawning season. Florida, for example, closes the snook season during two periods: when the fish are spawning and easy to catch and when they may be sluggish because of cold water.

When a species is in very short supply, the season may be closed year-around or for a major portion of the year. Another technique is the establishment of total catch limits (called quotas) for recreational and commercial fishermen. When these limits are reached, the season is closed immediately and does not open again until the next year.

Endangered Species

Few, if any, gamefish species are listed as endangered, but many have become species of serious concern. The striped bass in northeast U.S. waters is a case in point. For several years, the spawn has been minimal and populations have dwindled. Drastic management steps have been invoked, including size and bag limits plus seasonal closures. Tuna also were on the threshold of becoming endangered, but seem to be rebounding slightly.

Disastrous management has placed the king mackerel in jeopardy and may spell a similar fate for the Spanish mackerel, at least in southern waters. The big redfish is the latest species to have its existence threatened. Fortunately, strong management is helping the snook to slowly recover in Florida.

With modern methods and particularly the entry of sophisticated commercial gear into a fishery, populations can be wiped out in a matter of months. The balance is so delicate that constant monitoring is necessary to prevent a serious decline of any species. The same attention must also be given to baitfish because without the food source, the population of gamefish dependent on that bait will also decline.

Population dynamics apply to a species over its entire range and to a species in specific waters. If trout are lost in a stream that one fishes regularly, it does not really matter how abundant they are in another watershed. Lakes devoid of catchable bass are frustrating to look at and even more irritating to fish. Endangered should not really be the criterion to monitor. Rather, the key is to detect trends in declining populations and to take remedial steps before the situation deteriorates drastically.

Introduction of Exotic Species

Fishery managers are now aware of the consequences of introducing fish species into new waters. The total system must be studied in an attempt to determine the effect before the species is put into those waters. The brown trout in American trout streams has been a delight for most anglers. The carp has not been so well received. In the 1800's, striped bass were successfully planted along the Pacific coast and have provided a viable fishery since that time.

Peacock bass have been introduced in Hawaii and Florida, but not to any great extent. The question of what they will do to the native fishery still looms in the minds of managers. Other exotics that could be introduced, but certainly not before the entire ecosystem is studied. Once these fish gain a foothold, it is virtually impossible to eradicate them.

When the sea lamprey entered the Great Lakes, gamefish were victimized. By reducing the lamprey population and commercial fishing pressure, biologists were able to stock the Great Lakes with Chinook and coho salmon. Alewives were already present as a food supply. That fishery, of course, has mushroomed and remains strong, but possibly at the expense of native lake trout and white fish, The biologists who made the decision were not totally concerned because the salmon had to run up the rivers to spawn and most of the spawn had to be handled artificially. If something had gone wrong, the fishery could have been shut down. When asked why striped bass have not been introduced into the Great Lakes, biologists point out that a miscalculation of the consequences from this species may not be reversible.

Exotics can compete with native fish for space, food, and spawning habitat. However, successful exotics have filled a vacant niche. For example, the brown trout in North America, striped bass in reservoirs, and Pacific salmon in the Great Lakes are positive examples of exotic introductions. On the other hand, carp are an example of the introduction of an exotic that is now a common problem in many bodies of water.

Conflict of Commercial and Recreational Fisheries

Although recreational and commercial fishermen skirmish over fresh water species, most of the conflict occurs in salt water. The majority of fresh water gamefish are protected from commercial exploitation, making the market limited. Such is not the case on the oceans where a middle ground does not exist and battlelines have been drawn almost indelibly.

For many species, the total recreational catch is significant and has an important effect on the resource. However, the problem is compounded by sophisticated commercial fishing gear that can almost wipe out a population very quickly.

King mackerel had always been abundant in the Gulf of Mexico and Southern Atlantic. Hook and line commercial fishermen worked on these schools as did the recreational angler. Suddenly, a handful of roller rig boats, using spotter planes to pinpoint schools, entered the fishery. Stocks of this very popular fish dropped to disasterous levels. The problem was studied, but these boats were not eliminated from the fishery. Stocks have been decimated even further until a very serious situation exists.

A similar situation is present with Spanish mackerel and recently with large, spawning redfish. The problem focuses on the political ability of government agencies and the willingness of politicians to shut down a fishery in order to protect the resource while the necessary studies are undertaken. Concern should be directed toward the resource, not those who argue about it.

Longliners have seriously depleted the swordfish population on the East Coast. Tuna and billfish are also suffering. At one time, high seas netting of Atlantic salmon almost destroyed that fishery in the rivers because the netting was done indiscriminately.

One of the hottest battles currently involves the rights of native Americans to fish stocks, particularly in the Pacific Northwest and Great Lakes. Indians have the historic right through treaties to fish, but they often sell the catch, not allowable to commercial fishermen.

While heated arguments rage, the fishery must be protected. Those who want to continue killing the species argue that there is no conclusive, scientific data showing that which they are doing is harmful. Courts and governing bodies have sometimes followed this rhetoric and sided with it. The only meaningful answer lies in operating intelligently with the best information available or closing the fishery to everyone until sufficient data can be generated from which responsible decisions can be reached.

LESSON 26

Fisheries Management

LESSON
26

Fisheries Management

Lesson Objectives

Following this lesson students will:

1. Understand why hatcheries are important, the benefits of stocking, and stocking methods.
2. Understand why fishing regulations are necessary.
3. Realize why habitat management is necessary.
4. Know the role of surveys and research in angling and fisheries management.
5. Understand how law enforcement impacts fisheries management.
6. Be aware of funding sources for fisheries management.
7. Be familiar with the background and conflict of waterways allocation.
8. Understand some current and potential management problems.

Materials for the Lesson

1. Overhead transparency and photocopies of graphics from the appendix.
2. Any materials available from the state fisheries or conservation department and local or national conservation groups.

TEACHING STRATEGY

Lesson Content Outline	**Classroom Procedure**
	Due to the nature of this lesson, the local conservation officer would be a valuable resource person to present much of the materials, specifically what is being done in the area and the state. 1. Introduce students to the lesson objectives.
I. Hatcheries and Stocking A. Costs B. Size of Fish	2. Management is all those things which protect, enhance, improve, or maintain fisheries and fishing areas. Ask the students if they can identify anything that has been done in your area to manage fishing or fishing areas. Discuss several activities that could be included such as buffer zones, special limits, limitations on water use, etc., and indicate that they will all be discussed in this lesson. 3. Indicate that hatcheries are one major method of insuring that adequate numbers of fish will be available. Ask if anyone has visited a fish hatchery and if so, what they saw and heard there. Discuss the role of hatcheries in fisheries management, the costs involved, and the sizes of fish when they are stocked.
II. Fishing Regulations A. Creel and Size Limtis B. Slot Limits C. Catch and Release D. Other Regulations	4. Fishing laws and regulations are important in fisheries management. Even though these may have been discussed previously, review your state's fishing regulations and why they are necessary. Also discuss the role of "catch and release" in management programs, and what effect this can have on the resource, which species should be released, and how to properly release fish without harming them.
III. Habitat Management A. Stream Improvements B. Lake Improvements C. Artificial Reefs D. Weed Control	5. Ask students if they know of any activities to improve fish habitat in your area. They could mention dams, brush piles, etc., or reefs in saltwater. Discuss activities that are possible and how many local groups can get personnally involved. Discuss certain problems with habitat such as run off, too many weeds, acid rain, loss of buffer zones, watershed maintenance, and management techniques employed to overcome these problems.

Lesson Content Outline	Classroom Procedure
IV. Surveys and Research A. Role of Surveys B. Tagging C. Anglers Surveys D. Biological Surveys and Research	6. Discuss how surveys provide information on the needs of anglers, the fish harvest, and condition of fish populations and how this information is utilized to more effectively manage the resource.
V. Funding A. Licenses and Stamps B. Sport Fish Restoration Act C. Other	7. Discuss funding sources for fisheries management and that most funds are derived from user taxes and fees. Discuss the role of funds the states are allocated from the Sport Fish Restoration program and how the program is funded.
VI. Waterways Allocation A. Human Water Needs 1. Industrial 2. Commercial 3. Farming 4. Recreational B. Commercial/Sport Fishing	8. There is constant and increasing demand for water and its use from many sources. Discuss the industrial, commercial, farming, and recreational demands placed on our aquatic resources and the difficulty in allocating these resources. Often, water resources have a multiple use such as power plant lakes also being used by anglers, dams providing major reservoirs for recreational use, and for home waterfront building sites. In addition, commercial and recreational fishermen are often in conflict.
VII. Problems A. Depletion of Genetic Strains B. Overharvesting C. Loss of Habitat	9. Discuss the role of fisheries management in dealing with the problems of depletion of genetic strains, overharvesting, and loss of habitat. Ask the students to develop a list of things they can do to assist in fisheries management.

INTRODUCTION

Fisheries management is basic to the long term use of waterways and fish as a renewable resource, one that can be enjoyed by millions of anglers for years to come. Fisheries management addresses three major areas: (1) controlling fishing areas through habitat enhancement, watershed protection, and waterways stabilization; (2) improvement of fishing through structure additions, weed and pH control, stocking of easily raised and renewable species; and (3) the management of anglers activities through gear restrictions, size limits and creel limits, and seasons.

Effective management comes with research and education to inform the public of the rationale behind management tools including surveys, stocking and hatchery operations, allocation of water use, and concern for overharvesting of fish populations.

Available funding limits the use of management and management tools by biologists, waterways engineers and professional fisheries managers. Most funding is in essence a "user tax" since it is paid by fishermen through license fees, special fishing stamps and excise taxes on fishing tackle, motorboat fuel taxes, and import charges on boats and tackle. The user fees are returned to the states through the Wallop-Breaux amendments to the Sport Fish Restoration Act. Understanding of how these fees benefit anglers and what increased fees will accomplish helps anglers to accept these license fees and taxes and to realize how they directly benefit fishing.

It is also important to realize that management and conservation (See Lesson XXVII) are closely related, since conservation involves the preservation of fisheries and fisheries habitat while management involves the best planning and action for fisheries maintenance and enhancement.

NARRATIVE

General

Management of fishing and fisheries areas involves a number of methods. These include: (1) hatcheries and stocking of popular game species; (2) establishment and enforcement of regulations to prevent overfishing; (3) management and enhancement of streams, lakes, and reservoirs to stabilize populations; (4) surveys to determine angler needs and wants; (5) delicate waterway allocations to user groups including not only sport and recreational use but also industry, farming and commercial purposes; (6) research to address specific fisheries management problems and issues.

Management is all action which protects, enhances, improves or maintains fisheries and fishing areas. This includes such diverse activities as protection of a woods or forest serving as a buffer zone to prevent agricultural run-off, unique slot limits or catch and return regulations, protection of fish of certain species and size, and regulations limiting water use by some groups to protect the resource.

All of this must be funded, with most of the funding coming from special "user taxes" such as fishing licenses, boat ramp fees, boating gasoline tax, import charges on boats and fishing tackle, and special fisheries stamps.

Hatcheries and Stocking

Early attempts at raising fish for food go back to the Orient and early Roman times, but fish culture for sport purposes began in Europe prior to 1850. At that time fish hatcheries could be found for a number of species, even though at the same time, breeding and hatching trout in this country was still a novelty. Hatcheries might seem to be the solution for all fishing problems, since stocked fish from hatcheries could be raised to fill every anglers needs and wishes.

Hatcheries and stocked fish, however, can be expensive and are not always practical or possible. At one time, shad hatcheries abounded all along the East coast, but their minimal replenishment of the species and high expense has long since doomed them. There are very few hatcheries for salt water species. One example would be those for striped bass, (also stocked inland in lakes) currently of importance due to their alarming decline all along the east coast. However, technical difficulties are beginning to be overcome. Red drum, snook, and sea trout are now being raised successfully.

Even in fresh water, the costs, food needs, possible cannibalism and habitat requirements of different species makes some difficult to raise. Musky are very difficult to raise, since they tend to be cannibalistic and satisfactory foods and feeding systems are still being developed.

Trout, including rainbow, brown and brook trout are easier. They can be kept in large areas, exhibit little cannibalism, can be fed pelleted food and are easy to strip (remove the eggs and milt from spawning adults), fertilize and produce from eggs. However, even the trout species differ in cost effectiveness. Rainbow are the easiest and cheapest (and thus most heavily stocked by most states) while brown and brook trout are more difficult and costly.

The size of the fish stocked also determines the ultimate cost, and thus reflects the number of fish stockings that can be made with a given amount of license money. The smallest fish, called fry, are less than finger length and are generally inexpensive to produce. Little time, money, manpower or food is alloted to them, although their natural mortality is high when released.

Fingerlings, about a finger length or 3–5 inches long, are more expensive, but may still be economical with most species. The mortality will be less with these fish than with fry, but higher than with adult fish. The optimum size for stocking will vary with each species and situation, but usually fish 6–8 inches or longer will have low mortality if handled carefully. Obviously, larger fish are more expensive.

Adult fish can be economical or expensive, depending upon the species. Rainbow trout are generally less expensive than muskies.

There are problems associated with rearing fish in hatcheries. Under the crowded conditions of a hatchery, cannibalism can cause large losses. The fish also become trained to feed on hatchery food and need time to make the transition to wild conditions. In addition, there is greater opportunity for disease or fungus to develop. Fortunately, hatchery managers have learned to control most of these problems.

Most anglers like adult stockings, especially of trout, since these fish can be readily and immediately caught. However, the costs to fisheries departments are high. Stockings of smaller fish may be more cost effective and accepted by the fishing community, especially if time and conditions for growth in the wild is provided.

Hatcheries and the numbers of fish stocked depend upon anglers license fees or stamps, although the federal government also runs fish hatcheries to restore certain major fisheries or to mitigate for the effects of federal water development projects. Some of these federal stockings are allocated to the states each year. Other federal fish go to federal lands (e.g. Forest Service) or to interjurisdictional waters such as the Great Lakes or the Columbia River. Many states have "trout stamps" in addition to the standard fishing license which help pay for trout stocking and programs.

Fishing Regulations

Many popular game species such as trout and bass would be in danger of being depleted rapidly without regulations attempting to control their harvest. Fishing regulations encompass both size and creel limits. Size limits usually state the minimum legal size for specific species, the rational being to prevent small fish from being kept and to allow fish to spawn at least once. Some biologists now feel that this simple designation places too much emphasis and fishing pressure on larger fish. Slot limits where anglers can keep fish only above and below a certain specified size, and catch and return areas have become popular in some waters.

Creel limits regulate the number of fish that can be taken daily. They are usually based on an aggregate number, although some do specify limits for fish of a certain large size within that number. Possession limits are similar to creel limits, but specify the number of fish that can be in ones possession. Possession limits are usually equivalent to two or three days creel limit, and thus prohibit anglers from repeatedly catching creel limits and storing them in a cooler or freezer for future use. Creel limits attempt to distribute the catch among more people over a greater time period.

Slot limits allow harvesting of fish of only a certain size, and prohibit the taking of fish smaller or larger than that size. Many biologists believe that this is a better way to limit catches, since it protects not only the smallest of the species, but also requires release of trophy fish. These trophy fish can then be caught another day, help to repopulate the species during spawning season and maintain predator-prey balance.

Some state regulations restrict catches on some waters to only one large trophy fish, thus insuring that many will be left to replenish the species. Some fishing camps impose regulations that are more restrictive than state regulations. They realize that their continued success depends upon constant catches of fish and angler satisfaction.

Catch and release fishing is popular in some areas, with some states utilizing this as a method to limit harvest. It began with trout fishing, but now extends, on a volunteer basis, to many bass fishing tournaments as well. Catch and release fishing is usually limited to certain waters where fish may be caught, but must be immediately released. Variations of this are "lure fishing only" or "fly fishing only" and other regulations in which certain types of equipment (lures but no bait or traditional flies only) are allowed. Some fly-fishing-only streams even go further and require that all hook barbs be turned down so the fish can be easily released unharmed.

Other regulations prescribe the fishing seasons for selected species. Usually the closed seasons are those in which the fish are spawning. This prevents too many from being taken and permits adequate replacement. For similar reasons other regulations prohibit night fishing for some species, or establish off-limit areas on certain waters.

Regulations that prohibit the use of certain types of bait are enacted to prevent the entry of undesirable species into streams and lakes. Thus, a common regulation prohibits the use of goldfish, carp or species not bought from a bait shop. For the same reason, other regulations unilaterally prohibit any use of baitfish.

Habitat Management

Habitat management involves the protection, restoration, control, or enhancement of lakes, ponds, streams, rivers, and other habitat areas. In some cases, habitat management or improvement is accomplished with the help of clubs, scout troops, and community groups under the direction of state or federal fisheries agents.

Stream improvements can be accomplished by building small dams to raise pool levels, reinforcing banks with rock or logs, and creating cover from log and brush cuttings. On lakes and ponds the planting of structure such as weighted brush piles and Christmas trees, cutting and chaining shoreline logs for cover, planting water weeds, and building small reefs to hold fish can improve fish habitat.

Artificial reefs for both fresh and salt water areas are an important way to improve some fisheries and increase available fish. Reefs can be as simple as a concrete block weighted Christmas tree or as complex as the sinking of large scrap freighters, or sinkings of wired tires and concrete block and rubble. While artificial reefs connote a bottom structure, there are commercially available reefs that are anchored to the bottom but are mid-depth structures to attract fish.

Reefs for both fresh and salt water are important in two different ways. Structure will also hold, foster and develop algae, weeds, invertebrates, crustaceans, and other flora and fauna. These are the bottom of the food chain and the basis of life for larger bait fish and game fish species. Structure of this type becomes a cafeteria to provide comfort, safety and food. Reefs help to gather and hold fish. Fish which seek structure will not stay in areas with plain flat bottoms. Structure in these areas gathers the fish and makes for excellent fishing.

Water pH within certain narrow ranges close to a neutral pH of 7.0 is important for the maintenance of fish life. pH of 7.2–8.3 is typical, 6.0–9.0 pH is acceptable, and pH of 5.5–9.5 is tolerable. However, fish prefer neutral (pH 7.0) or slightly akaline (up to pH 7.9) water. Acid rain, acid mine run-off and acid industrial pollution makes pH abnormally low (very acidic—pH 4.0–5.0) and kills fish life and fishing areas. Some pH control is possible, either by using crushed limestone (alkaline) in affected streams and lakes by releasing limestone slurry in careful doses to counteract any acid influx into the water. However, pH control is temporary, expensive, and needed most in those waters that naturally are least productive.

Weeds are important in most waters. They provide a basis for the food chain, provide protection for fish, and convert carbon dioxide to oxygen. However, uncontrolled weeds can be bad, since they will choke waterways, make boat traffic impossible, and begin the eutrophication (over enrichment) process of small lakes and ponds. In some areas, artificially introduced plants such as hydrilla have become serious problems. There is no simple answer for weed control, although cutting, poisoning, uprooting and the introduction of other species to eat or destroy the plants have all been tried.

Temperature is the most important factor affecting the species in a given body of water. All species have a range of preferred temperatures. Warm waters are best for the so called warm water species such as sunfish and bass, while cold waters are best for cold water species such as trout and salmon.

Watershed protection will help maintain a cool temperature for trout streams. Temperature can be controlled in streams running from dam outlets by controlling the level of the outlet from a dam. High outlets result in higher water temperatures; low outlets mean colder water temperatures. Since most dams are on fast flowing streams, the low outlet for cold water is preferred for trout habitat. However, low outlets often result in water with little or no oxygen, and baffles leading from the outlet to the stream are often used to aerate and oxygenate the water.

Watershed maintenance involves everything from watershed protection to clearing of hazardous snags or obstructions. All waterways need a suitable buffer zone of forest land around them to protect them from rapid run off of water, mudding of the water, run-off of pesticides, herbicides, insecticides, and fertilizers from nearby agricultural areas, and adequate natural shoreline to protect against erosion. Good agricultural practices, control of urban development, and pollution control are vital components of watershed management.

Surveys

Management surveys provide information on the needs of fishermen, the fish harvest, and the condition of fish populations. Surveys can include tagging of fish, angler surveys, and biological surveys.

Angler surveys are done in two ways—access point and roving. Access point surveys are usually done at dockside to compile information. Fishing success, rate of catch, catch per unit of effort, number and size of catch, equipment used, locations fished, and similar information is recorded. Roving surveys are done on the water. This information can then be utilized to determine the need for creel or size limits, seasons, or stocking programs.

Biological surveys usually involve electro-shocking, poisoning or netting. In shocking, waters are electrified with special equipment to temporarily incapacitate the fish which can then be gathered for quantitative and qualitative data. Netting is another method to gather fish data. netting is usually done by several agencies netting at the same time and place, to eliminate variables. The agencies can build a baseline of biological data trends including information on the habitat and the food chain. Poisons, if used properly, are effective for certain tasks and pose little danger to people.

Rotenone is used to renovate lakes, i.e., kill all fish to allow for "starting over" and stocking desirable fish. Also, TFM is an effective, selective lampricide used effectively in the Great Lakes to control sea lampreys.

Tagging involves placing a tag or mark on fish. This allows biologists to obtain important information on growth rates, migrations and movements, species health, weight increases, and similar data. Comparison of data from the time fish are released to similar data gained upon capture, gives fisheries biologists important information.

Tagging is done in general or specific ways. Fish are marked through a clipped fin to obtain general information. This, however, will not provide data on fish growth (other than general data) since specific fish can not be measured.

Funding

Most fisheries operate on funds derived from user taxes and fees. Hence the funding comes either directly or indirectly from those who use the resource, in the form of license fees and special use stamps. Usually the license provides funding for general operation of a fisheries department (or in cooperation with hunting licenses in a combined department) and general fisheries management. For those fisheries requiring special efforts or involving expensive methods (such as hatchery operations and stocking) a special use stamp may be required to cover the costs.

Additional funding for fisheries management and conservation comes from the Federal Aid in Sport Fish Restoration Act. The Sport Fish Restoration Account receives:

1. all monies in excess of a specified amount which is provided to a Boating Safety Account. After FY 1987, the Sport Fish Restoration Account will receive all funds in excess of $45 million annually collected from motorboat fuel taxes.
2. all manfuacturers' excise taxes from fishing tackle and tackle boxes (10%), flasher type fish finders (3%), and electric trolling motors (3%).
3. all duties assessed on imported yachts and pleasure craft and imported fishing tackle.
4. interest on funds deposited but not yet expended from the account.

These funds are apportioned to the states based on a formula weighted 40% on the basis of land and water area including coastal and Great lakes waters; and 60% on the basis of paid fishing license holders. No state receives less than 1 percent of the available money nor more than 5 percent. Since approximately 6% of the funds are utilized for administration, over 100 million is available for use by the states.

The monies may be utilized for sport fish restoration and enhancement activities including: lake construction, motorboat access, fisheries management and research, and aquatic resource education. This highly effective program is administered by the federal government.

Allocation of Water/Aquatic Resources

Water is basic to human life in a variety of ways. Not only can we not live without water for more than seven days, but water is also necessary for manufacturing, for trade (shipping lines), for housing developments (thus increased prices for shoreline property), for farming and for a variety of recreational interests.

There is a constant demand for water from a variety of areas, all vital in their own way, but all in a way destructive to the natural waterway. The great amount of water needed for the production of aluminum might affect water useage in that area. Water utilized and released in chemical and steel production will pollute waterways if not monitored and treated. The damming of a stream for flood control or irrigation may deplete water flow down stream, affecting habitat and fisheries. A reservoir formed for recreation might be applauded by swimmers, water skiers, sailors, and boaters and lake fishermen, but ruin the favorite recreation of river canoeists, stream fishermen, and white water rafters.

Constant water monitoring is required along with adequate controls to assure that the quality remains high. For the conflicting areas of water useage, a balance must be met to assure that industry, farming, commercial and recreational needs— including many forms of fishing—are all treated fairly.

When fishing is the sole concern, conflicts usually arise over commercial and sport fishing in salt water areas. Since most freshwater commercial species such as trout and catfish are raised in ponds and most freshwater commercial fishing is concentrated on species other than those sought by sport anglers, conflict seldom occurs.

Commercial fishing and sport fishing are often in conflict with of the numbers of fish caught and the economic importance of those fish. The economic importance of commercially caught fish is usually rated at the dockside price of the catch. The economic importance of sport fishing is far broader and more important to many communities, since it involves tackle sales, gasoline (for boats and for cars to reach the area), convenience store sales, motels, grocery stores and restaurants, charter boat rentals, party boat trips, and boat rentals. Estimates indicate that sport fishing is a $25 billion annual business while similar figures for commercial fishing reach about $9.2 billion.

Problems

Fisheries management seeks to avoid problems through preventative measures. Some problems facing everyone—but are generally solved through management programs include:

Depletion of Genetic Strains of Fish

Biologists carefully control species so that hearty, viable strains are produced in hatcheries. A problem can develop when a hybrid is introduced in an area in which one of the parent species is still present. A dilution of genes or a loss of the original species can occur if the hybrid proves to be more adept in adapting to the environment, or if it proves to be a more dominant strain than the original stock.

Overharvesting

Controlled size and creel limits and constant monitoring and surveys by fisheries biologists can keep this from happening. When it becomes a danger, emergency regulations usually allow for closure of an area pending a more detailed survey and analysis.

Loss of Habitat

This is by far the greatest danger, since it is generally out of the hands of fishermen and fisheries biologists. Housing developments, shopping malls, industrial plants, human consumption, irrigation, loss of buffer zones, and accidental spillage from boats can reduce or completely eliminate habitat areas or cause loss of natural waters.

LESSON 27

Fisheries Conservation

LESSON
27

Fisheries Conservation

Lesson Objectives

Following this lesson students will:

1. Understand how available habitat, food, water conditions and watershed conservation affect fish populations.
2. Understand the difference between quantity and quality in fishing.
3. Be aware that acid rain, watershed loss, and changes in waterways require the use of conservation practices to maintain the resource.
4. Understand the difference between conservation and preservation.
5. Realize that poaching, overharvesting, loss of habitat, and lack of education and understanding are major problem areas for fisheries conservation.

Materials for the Lesson

1. Overhead transparencies and photocopies from graphics in the appendix.
2. Materials from the state department of natural resources or from local and national conservation groups.

TEACHING STRATEGY

Lesson Content Outline

I. **Population Dynamics**
    A. Fish Populations
    B. Quality versus Quantity
    C. Boom Fisheries
    D. Natural Population Fluctuations

II. **Environmental Problems**
    A. Acid Rain
    B. Watershed Loss
        1. Developments and Housing Projects
        2. Destructive Practices
        3. Channelization

III. **Conservation Practices**
    A. Fish Management
    B. Water Quality
    C. Watershed Protection
    D. Aquatic Food Chain Biology

IV. **Conservation Versus Preservation**
    A. Wise Resource Use
    B. Resolving the Conflict

Classroom Procedure

Due to the nature of the content of this lesson you may wish to involve a conservation officer, fisheries biologist, high school teacher or other consultant.

1. Introduce class to the lesson objectives.
2. Conservation is the wise use of our natural resources (aquatic resources) without enhancing or embellishing them, but always with the thought of preserving and protecting them for the use of future generations. Discuss this concept with the students so that it is understood and that it requires a knowledge of the production that can be sustained from an ecosystem. It also involves and an awareness of environmental factors which can enhance or harm the fishery.
3. Discuss population dynamics and the fact that regardless of fishing pressure, natural causes create flucuations in the numbers of fish available, their size, and the carrying capacity of a given body of water.
4. Discuss a "boom" fishery. A prime example is the rebirth of Lake Michigan and the stocking of salmon and trout which have totally revitalized this area. Other examples in the local area may have more direct impact on the class and should be discussed.
5. Conservation becomes much more complex with factors that directly affect them and over which we have only limited control. Discuss the effect of acid rain, and watershed loss through development, "point source" pollution from industry, channelization, farming, and temperature pollutants, and the difficulty in conservation as a result.

V. Problem Areas
- A. Poaching
- B. Overharvesting
- C. Lack of Education and Understanding

6. Conservation practices and management of fisheries are interrelated. Fish management, water quality, watersheds, and protection of the entire food chain are necessary for conservation to be totally effective. Everything is interrelated, and a change in one area can effect the end result. A parallel can be drawn between an automobile accident involving several cars caught in a chain reaction to the problem with a break in the food chain to the result at the end.
7. Aquatic resources are renewable. Fish not caught and utilized will utimately die, replaced by others of the same species. Most conservationists believe that utilization of renewable resources can be enjoyed without destroying the resource. Some people feel that these resources should not be utilized in any way. They are often called preservationists or "animal rights" advocates. Most professional wildlife managers consider this an unrealistic view. This controversy can result in a lively class discussion.
8. Poaching and the taking of more fish that can possibly be used, even though there is no creel limit, are two major problems in conservation efforts. Discuss these factors and ask students to suggest ways that they can become involved and make a contribution in these areas. Educational efforts help.

INTRODUCTION

Conservation and management of fish and fish habitat are closely related. (see Lesson XXVI—Fisheries Management). Conservation involves the wise use of areas and species, not by enhancing or embellishing those species or areas, but with the thought of preserving and protecting resources for the use of future generations.

Conservation is based on an awareness and understanding of basic biological principles. It requires knowledge of the levels of production that can be sustained from each ecosystem and of the effects of the utilization and harvest on the population of a given species. It involves an awareness of environmental factors which can enhance or harm fisheries, such as the introduction of a species, creation of boom fisheries, the destruction by acid rain and watershed loss adversely affecting water quality and sport fisheries.

One conflict often gaining much press coverage occurs between those interested in conservation with utilization of a species versus those interested in complete preservation and protection with no outside human influence, such as fishing. Preservationists and animal rights advocates generally are more interested in the welfare of individual animals, while conservationists are primarily concerned with populations, communities, and the sustained welfare of the entire system.

Poaching, overharvesting, and destructive land and water practices are all areas of concern which are damaging to conservation efforts. These are best addressed through education to create increased understanding and broad support of basic conservation principles along with vigorous law enforcement.

NARRATIVE

Population Dynamics

In a natural state, the population of a given fish species contains fish of varying sizes. Most fish lay large numbers of eggs—numbering into the tens or hundreds of thousands. Only a few reach adulthood. Many eggs, fry and fingerlings, are eaten by large fish or are subject to the harsh whims of nature. Natural disasters such as freezes, drought, and heavy rain can cause large fish kills, destroy habitat, and rearrange waterways.

Largemouth bass become solitary for much of their life, staking out the best spot in a lake or stream through a "pecking order" similar to that found in common terrestrial species. Thus, the largest and most belligerent fish will take the best stump or log as "home", leaving the smaller fish to fight among themselves for less desirable areas.

Sunfish form random schools, while true schooling species such as trout, salmon, and shad remain in schools of their year class (hatching year) with all members of the school remaining similar in length and size. As the fish age, schools become smaller, a result of natural predation of the species, accidents, disease and other natural disasters. The population dynamics of any given species is then shaped like the pyramid of the basic biological food chain. The smaller of the species are more numerous.

Anglers fishing such an environment (which will basically exist with or without fishing or other pressures) have a choice between many small fish or a few large fish. Each aquatic system has a limit as to what it can produce in a given time period. Watershed geology, climate, and the shape of the lake are fundamental factors determining carrying capacity. The "balance" of species also affects the productivity of each system, although carrying capacity seems to be the major factor. Thus a 1000 pound capacity might be made up of 900 lbs. of mixed size bluegills and 100 lbs. of bass or 995 lbs. of uniform, small bluegills and one 5 lb. bass. When fishing for schooling fish, each fish is very close in size and weight to all the others. When fishing for randomly scattered fish, the catch will vary in size with most of the fish being smaller.

The one exception to this can occur in the so-called "boom fisheries." Boom fisheries may develop when a new reservoir is constructed or a new species is introduced into waters where no competition is present and food is plentiful. Here, large numbers of large fish can quickly grow to maximum size, fueled by the lack of disease, predation and danger and with plenty of forage fish. An example are the salmon and trout fisheries in the Great Lakes, which from their initial stocking in the late 1960's and early 1970's produced a boom fishery that continues almost unabated today.

Environmental Problems

Conservation and protection of fisheries become increasingly difficult with factors directly and adversely affecting them. Some species have become extinct a a result of extensive pollution or overharvest. The blue pike of the Great Lakes is thought to be extinct as a result of the massive pollution and overharvest of Lake Erie. The extent of this pollution culminated in the Cuyahoga River, a Lake Erie tributary, catching fire in 1969.

Some waterways have become devoid of fish and aquatic life as a result of damaging ecological conditions. Hundreds of ponds and small streams in Northeastern U.S., parts of Canada, and even the Great Lakes area are devoid of life, allegedly as a result of acid rain and snow.

Environmental problems can be caused by anything that changes the character of water from its normal state. Factors which can affect waterways, thus fish, include:

Acid Rain: According to the experts, acid rain results from high sulfur content coal used in many industries. The lack of smoke stack "scrubbers" that clean the smoke causes the release of high sulfur smoke to the air where it becomes sulfuric acid. The natural winds and currents carry rain clouds laden with acid rain east and northeast.

Acidic streams, lakes, and ponds are then created by acid rain. The acid destroys the biological food chain and directly harms fish as well. Even without direct harm, the effect on the food chain can cause a reduction in populations.

The greatest damage from acid rain is probably to the watershed. Acid rain's major impact has been on poorly-buffered, low productivity, but clean and beautiful lakes. The actual loss to fishing has been relatively small, but acid rain is an extremely complex and important problem. As with many problems, the "weakest" go first but should provide a warning to the "stronger."

Industrial Pollution: Industrial or "point source" pollution can come from many sources including heavy metals, chemicals, and solvents. In the past, kepone poisoning of fish in the James River in Virginia extended into the Chesapeake Bay. PCB's are a problem in the Hudson River and the Great Lakes, and mercury is a concern in many lakes in Wisconsin and Minnesota. Some pollutants are thought to cause deformed fish, loss of eggs, sterile fish, and diseased fish. Such pollutants are usually introduced into the water directly, although some leakage from land or land-bound sludge ponds also occurs. Recent state and national legislation has done much to clean up these problems, but more must be done to complete the task and to prevent future occurrences.

Farm Pollutants: Herbicides, pesticides, fertilizers, and soil particles, including phosphorus and nitrogen, are major farm pollutants, sometimes called "non-point source." These are more stringently controlled than in the past but still can easily enter most waterways and upset the biological chain of life. Phosphorus and nitrogens found in many fertilizers fertilize plant life and algae growth, causing plant blooms which ultimately die. This process consumes oxygen, making it difficult for most fish species to live.

Temperature Pollutants: Even clean industries which do not produce pollutants into a waterway can cause harm. Many power plants are located on rivers to use the water as a coolant for nuclear reactors and stream turbines. However this heated water is reintroduced to the waterway, causing two problems. First, the heated water creates an unnatural element for the fish. They concentrate in this warmer water in the winter, but if the heated water is stopped, it may cause them to die as a result of sudden temperature change. The second problem concerns the intake water drawing in with it tiny invertebrates and crustaceans that, in turn, are killed, thus taking them out of the food chain for the small fish in the river. In addition, the intake water causes small fish and fingerlings to become caught on the protective screens since they do not have the size or strength to fight the current.

Water Quality: The lack of water clarity caused by stirring the water is also a pollutant of sorts, as is siltation caused by poor tillage practices and construction sites. It makes feeding difficult with reduced visibility and causes silt deposits on beds during spawning that destroy most eggs. The silt can also cover and destroy many small plants and animal life, affecting fish eggs and the food chain.

Watershed Loss: A watershed is the area drained by a river system or by smaller streams, lakes, and ponds in smaller basins. The loss of trees, brush, and grasses on the shores of lakes, ponds, or streams, also called "riparian habitat", has serious consequences for water quality. This can be caused by poor forestry practices or by cattle overgrazing, thus affecting water in several ways. First, it eliminates the natural growth which has roots extending into the shoreline. This, in turn, allows for soil erosion, causing a loss of shoreline, increased turbidity in the water with the resultant loss of eggs, and invertebrates, and siltation of the bottom.

The lack of foliage and poor soil conservation practices in a watershed allows quick run off, increases the hazards of acid rain (if it exists in the area) increases soil erosion, changes water temperatures, and causes fluctuating water levels, all of which can be harmful.

Channelization: Straightening or channelizing streams for navigation, agricultural purposes and flood control is a relatively recent practice. The purpose is to allow for a quicker flow of water, thus presumably less flooding. This result is not always achieved, and in the process, a stream is completely ruined for most aquatic life forms. Channelization destroys the natural habitat of fish, their food and the biological chain of life. It makes currents that are impossible for any but the larger species to cope with, often increases stream temperature by destroying shade covered eddies, eliminates hiding places for fish, and may increase downstream flooding.

Conservation Practices: Conservation practices and management of fish and fisheries are interrelated. While conservation is the wise use of natural areas and waterways for the maintenance and protection of fish and other plants and animals, it is based on sound fisheries management.

Water quality is important to fish survival as well as for man's use. In some states, reservoirs are used for fishing, but the stringent water quality standards and regulations prohibit the use of gasoline powered outboards. The spillage of gasoline from outboards probably does not harm the fish, but gives the water an "off" taste. Gasoline can be removed through an expensive activated carbon process or by utilizing hydrocarbon bacteria which do a faster job. With a cooperative effort between the general public and the fishing public, fishing is allowed but only electric motors are permitted. As a result, the water quality is determined by the needs of both people and fisheries.

In some cases water quality is almost impossible to guard, as in areas affected by acid rain. Most other problems can be dealt with through legislation establishing buffer zones to help control industrial or farming pollutants or through watershed protection, legislation requiring a buffer zone of vegetation around all waterways.

Waterways protection is vital and can involve everything from legislation to require a buffer zone of natural watersheds around waterways and outright purchase of the watershed by the state or private conservation groups, to rip rap and gabions (wire encased stone bulkheads) to protect the shoreline.

A vital aspect of all protection is a realization that not only adult game fish need continuous protection, but also that the whole waterway of lake, pond, stream, marsh, bay or ocean must be protected continuously to allow for the biological food chain to thrive. Without the biological food chain, there can be no game species on a continuing basis. Game species are completely dependent upon adequate reproduction, good water quality, and the chain of life that provides a basis for eggs, fry, fingerlings and forage fish.

Conservation versus Preservation

Resources such as minerals and oil are nonrenewable. When man removes them from the ground, there is no replacement process to produce more. Others resources such as fish, forests, animal and plant life are renewable. Forests can be cut, replanted, and harvested like any other crop.

Likewise, fish are renewable. Fish not caught and utilized will ultimately die, replaced by others of the same species. Death can be from disease, predation, lack of food, overpopulation or other factors. Most conservationists believe that utilization of renewable resources including harvesting forests, hunting of game animals for sport, fishing, or in some cases, subsistence can be enjoyed without destroying the resource.

Preservationists feel that taking of natural resources is wrong, and that fish, game and forests should not be utilized in any way. Most professional wildlife managers consider this an unrealistic view.

Conservation does require careful monitoring of these renewable resources. Creel and size limits on fish protect the species and allow the taking of reasonable numbers for sport, while not affecting the population as a whole.

One possible resolution is to allow some selected areas to remain untouched by man and to permit only natural factors to affect the fish, game and flora.

Problem Areas

Understanding the basics of aquatic biology makes it easier to understand and realize why biologists and fisheries managers must formulate management plans that may include size and creel limits. Naturally, these plans should vary among species and specific waters. Some species have much higher reproduction rates, which allow extensive fishing without size or creel limits. While state and local regulations vary with each species, typical species requiring few restrictive limits include fresh water sport fish such as panfish, suckers, catfish, perch and crappie, and salt water game fish such as perch, sea bass, west coast rockfish, bluefish, sea trout, dolphin, and mackerel.

Poaching is the illegal taking of fish, either by taking too many fish, taking them too frequently, taking them out of season or in an illegal manner. Poaching can involve traditional fishing methods during a closed season or taking fish by baited trot lines, brush bobs (lines attached to a shoreline bush which may be permitted in some states), netting, poisoning (rotenone), or explosives.

Poaching robs all of us since it can destroy many fish along with habitat (explosives or poisoning), can take large numbers of fish (netting), and when practiced extensively can quickly reduce any waterway toward being almost devoid of fish.

Overharvesting technically can be considered poaching, but is not thought of as damaging or as "bad" as true poaching by many anglers. Overharvesting can be either legal or illegal. Illegal overharvesting includes taking more fish than the law allows, or taking the limit and "adding" fish allowed to a less fortunate angler. Thus, with three anglers fishing together with a limit of ten fish per angler, each angler is only allowed ten. Some anglers (and the same flawed thinking also applies to some hunters) take fish on another bag limit (with permission, but still illegally) until all limits are filled, 30 fish in this hypothetical situation.

Legal overharvesting can include the catching of more fish than can possibly be used for food, even though there is no creel limit. Some species do not have creel limits and could be legally caught by the hundreds.

This does not mean that fish should not be caught, only that most species of fish should be released once a sufficient amount for food is caught. Hence, overharvesting becomes an ethical or moral issue, not a legal one.

An understanding of biological processes is critical to compliance with fisheries law. Knowledge of the purpose of creel and size limits and the effects of dumping liquids or solids, clear cutting crops or forests all the way to a shoreline, polluting a lake, or destroying stream beds or habitat containing fish food insects on the resource is important to the preservation of resources.

Natural things are all connected in some way. Water quality is affected by the air pollutants (acid rain), soil (erosion and soil run off and siltation), pollutants (from upstream areas and unrelated industries and farms), and housing (developments especially along the shoreline that destroy wetlands which are the nursery areas for many fish species).

Education, such as encompassed in this series of lessons on fishing and aquatic biology, is necessary if conservation is to be a meaningful, workable, understandable concept rather than an abstract theory with no practical application. A lack of conservation practices by only a few can affect the beauty of natural outdoor world, the pleasure received from all water related sports and the quality of the fishing experience.

LESSON 28

Fishing Ethics and Your Personal Commitment

LESSON
28

Fishing Ethics and Your Personal Commitment

Lesson Objectives

Following this lesson students will:

1. Know that each angler has a personal responsibility to fishing and the aquatic environment.
2. Have an understanding and a respect for the resource.
3. Understand the importance of catch and release.
4. Know what is expected of them in relation to other anglers, land owners, and non-fishing resource users.
5. Have a basis to develop their own sense of ethics.
6. Be familiar with fishing regulations and why they are vital to the survival of the fishery.
7. Know how to get involved individually and as part of a group to protect the environment and the fishery.
8. Understand why fishing is an enjoyable recreational pursuit.

Materials for the Lesson

1. Copies of local and state fishing regulations.
2. A list of local fishing clubs and conservation organizations, and their counterparts on a regional and national level.
3. Photocopies and overhead transparencies made from graphics in appendix for distribution to class and for use as teaching aids.

TEACHING STRATEGY

Lesson Content Outline

I. Introduction

II. Personal Fishing Responsibility
- A. Ethical Behavior
- B. Legal Behavior
- C. Personal Action and Responsibility
- D. Minimize, Not Intensify Individual Impact
- E. Respect for the Resource
  - 1. Catch and Release
  - 2. Litter
  - 3. Education of Anglers

Classroom Procedure

This lesson on ethics and your personal commitment is another that can be extended to several class sessions. However, the students, no matter how young, should understand that ethical behavior is judged as being right or wrong on a set of moral values. Legal behavior, on the other hand, judges behavior as right or wrong on a set of written laws. Therefore, some behaviors may be legal, but may not be ethical. Ask the students if they can think of any examples where this might be true. Prompt them by asking if making a lot of noise near a fisherman is ethical behavior. It is legal, but is it ethical. List several of their responses on a blackboard or easel.

Our actions and behaviors effect the environment directly, either in positive or negative ways, and therefore effect others who use the outdoors and our aquatic resources. We/they all have a responsibility to become personally committed to preserving and enhancing our aquatic resources through positive involvement, on an individual or group basis.

1. Introduce students to the lesson objectives.
2. Discuss the role of the individual angler and his/her attitude to our aquatic resources. Each angler must recognize that whatever is done has an effect on the resource. Efforts must be taken to minimize, not intensify this individual impact. Ask students what they can do. Responses could include not discarding soda cans or candy wrappers on banks or in the water; keeping only enough fish to eat and returning the rest for another day; or becoming involved in a "clean up" project. Note these suggestions on the chalkboard as they are mentioned and discussed.
3. Ask students what the cumulative impact on the resource would be if each angler made a personal commitment similar to those mentioned. For example, if every angler released just one trophy sized sport fish to spawn again? How many millions of fish would that add to the resource? Many game fish, both fresh and salt water, are scarce today. This effort could have a tremendous impact on the fishery each year. Also, everything in the aquatic environment is related to everything else. When a balance is lost, there is a tremendous effect on the aquatic resource. Ask students how educating anglers can impact the resource? Would knowledgeable anglers behave in an ethical manner that would have a positive effect on the resource? Perhaps this would lead back to the importance of attitude, which is paramount.

Lesson Content Outline	Classroom Procedure
F. Respect for Others 1. Fisherman 2. Landowners 3. Non-fishing Users	4. Not only must anglers respect the resource, they must respect others who use the resource. Ask students to suggest other users/people that are effected. Use overhead transparency produced from graphics in appendix to stimulate their thinking. Asking permission to fish on private property and them taking care of that property are two major ethical actions. Ask them for others. Suggestions could include references to water skiers, other anglers, landowners, hikers, campers, etc. Have students list behaviors, be as specific as possible, that would show respect to these groups.
III. Familiarity with Letter and Intent of Fishing Regulatiosn	5. Fishing regulations have been established to protect the resource. All anglers have a responsiblity for following written laws and regulations established by state and or Federal authorities. Discuss several of the reasons why these regulations are necessary. Distribute copies of your state's pamphlets on Fishing Regulations. Review some of the basic fishing regulations that are important such as seasons, limits on locally popular fish, and possession limits. Ask students what their ethical responsibility is if they know of someone who is flagrantly violating these regulations.
IV. Sportsman Involvement and Responsibility A. Legislative Actions 1. Ecologically Based 2. In cooperation with state conservation agencies B. Organizations C. Personal Actions	6. Discuss with students why we each have a responsibility to become involved in protecting aquatic resources. Student responses should be listed on the chalkboard. Include in the discussion individual and joint state conservation efforts, legislative actions that can be taken, and organizations that can be joined. Many local groups such as the Izaak Walton League have an active national organization. Others include the National Wildlife Federation, The Audubon Society, Sierra Club, the Nature Conservancy, and the Sport Fishing Institute. Others such as the Coastal Conservation Association emphasize salt water species.
V. Why Fishing Is a Good Environmental Sport and Recreation	7. Angling is a sport enjoyed by all. Participation is not limited by age, sex, religion, or anything else. Ask the students to list why fishing is a good environmental sport and recreation. Your list on the chalkboard will be lengthy. Then refer them back to their responsibilities and discuss how much they have to gain by becoming actively involved in preserving and enhancing our aquatic resources.

INTRODUCTION

Fishing is an extremely personal pursuit. An angler may opt to fish passively, sitting on the bank of a creek, pond, or lake. Another fisherman may take a more aggressive approach and actively stalk the quarry. The level of participation chosen is not something to be judged by others. It is an individual decision in the search for enjoyment, relaxation, and delicious, healthful food.

Each enthusiast, however, must shoulder a responsibility for the resource. There is a growing necessity to determine one's own fishing ethics aimed toward insuring that the same opportunities will exist for future generations. This is a personal commitment that must be followed diligently without policing.

For some, it goes beyond the attitude afield or the respect shown to others. This commitment is much more than simply obeying established rules and regulations. It may foster individual effort to leave the aquatic environment in better condition than found,or it may encourage an angler to become part of a group battling for the future of the resource.

No matter how ethics and commitment manifest themselves, they must be addressed by everyone who plans to participate in fishing and to use the aquatic resources of this great land.

NARRATIVE

Personal Fishing Responsibility

Many economies respond to supply and demand. In theory and often in practice, as the demand for something increases, the supply rises to satisfy that demand. It may take a little time for supply to catch up to demand, but the curves will eventually cross.

The demand for a specific species may skyrocket as more anglers discover the fun of fishing. Those who probe a certain lake, stream, or estuary may want huskier specimens than they are presently catching. Others may demand more fishable water. Increasing the supply of fish to respond to these requests becomes extremely complex and, in some cases, borders on the impossible.

Housing developments, shopping centers, and schools convert pristine natural habitat into what might be termed by some as more civilized surroundings. In the process, aquatic resources are lost. Pollution in various forms lowers the fish-carrying capacity of other waterways and diminishes the resource. Each body of water has a finite limit on the number of each species it can accommodate, and unlike a factory that expands to meet product demand, aquatic resources tend to diminish rather than to increase.

It is possible, of course, to reverse the trend, but it is doubtful that will happen. However, of immediate concern are measures to protect and preserve that which is available today for future generations. At the rate aquatic resources are being lost, preservation, in itself, is an awesome commitment.

All of this funnels down to the individual angler and his personal fishing responsibility. It is easy enough to let the other person worry about tomorrow. However, if everyone subscribed to that philosophy, there would be no one to assume stewardship for the resource. Rather than leave this responsibility in the hands of someone else, fishermen must become personally involved.

Minimize, Not Intensify Individual Impact

The impact of an individual angler measured against the total resource might seem insignificant. Does it really make a difference how many fish he packs into his cooler or how he treats the habitat? Only one angler would not alter the overall picture dramatically but his impact has a cumulative effect. What one person does adds to the behavior and attitude of the next and the next.

Estimates indicate six million residents and visitors fish the waters of Florida each year. Few consider it excessive to keep ten pounds of fish per year. That is less than a pound each month. On an individual basis, an angler would certainly be practicing conservation and treating the resource with a great deal of respect. However, if each of the six million anglers took ten pounds of fish per year, the resource would be depleted by 60 million pounds.

The bottom line becomes one of attitude. Each angler must recognize that whatever he does has an important effect on the overall picture. Through research and effective fisheries management, man can deter the current trend of decline and even restore certain habitat. No greater example exists than the Great Lakes fishery for salmon and trout. By controlling the lamprey and commercial harvest, scientists made the habitat conducive to the survival of game fish since the food supply was already there in the form of alewives. But breakthroughs of that magnitude do not happen often.

The continuation of the salmon fishery in the Great Lakes depends upon science. Very little natural spawning takes place. Instead, females are stripped of their roe which is fertilized with the milt from males. The eggs are then placed in a fish hatchery. Juveniles are planted in the streams and rivers so that they will be imprinted with the scent of those waters and return to spawn when they are mature.

With all species of fish, care must be taken to insure that an adequate spawning stock remains to produce ongoing year classes. At times, it is necessary to institute regulations to make certain the spawn occurs.

One method is to establish a minimum size limit, usually a length at which the fish will have spawned at least once. In certain cases, maximum size limits are established because only the larger fish spawn. It is important to understand that these restrictions are not arbitrary and should be followed, for future fishing depends on it. Providing food for the family is one of the leading reasons given by recreational anglers for sport fishing. If a fisherman understands the fragile resource, he can be encouraged to concentrate on a variety of species for food.

Respect for the Resource

Some fish are far too valuable to be caught only once. This theory has been advanced by concerned anglers who have supported and nurtured catch and release programs. The fishery resource must be respected and protected. A growing number of anglers now take only what they need for food and release the rest of the catch unharmed.

Trout and salmon anglers traditionally release most of the fish they catch and an increasing percentage of bass fishermen are doing the same. The more people who selectively practice the catch and release philosophy, the healthier the resource should become. Some folks argue that the fish die when turned loose, but that argument has little validity in the scientific community, especially if the fish have been handled properly.

Fish species which take longer to reach maturity and those which spawn a limited number of times are more suseptible to overharvest. These include bass, musky, pike, walleye, salmon, trout and most large game fish.

The longer it takes a fish to reach a reproductive age, the more easily it can be depleted. Perch, bluegill, bullheads, and most other panfish spawn after only 2 to 3 years. To the contrary, walleye, musky and bass may not spawn before 3 to 7 years of age therefore, more susceptible to overharvest.

A fish destined to be released should be landed quickly while it still has plenty of strength. Handling should be kept to a minimum. Unhook the fish as gently as possible, keeping it in the water. If the hook has been swallowed or is difficult to remove, simply cut the line as close to the hook as possible. The hook will rust out or become dislodged naturally.

No one can adequately describe the marvelous feeling experienced when a game fish is released and swims away. It fosters an inner satisfaction that outweighs the momentary glory of showing the fish to other people. Many fish are photographed and then quickly released. The picture will trigger fond memories and the fish can bring another angler much enjoyment.

Until recently, few anglers ever dreamed that the supply of certain game fish in the ocean would become threatened or that hatchery operations would be started to stock the Atlantic or the Gulf of Mexico. Redfish, snook, seatrout, striped bass, and other species are presently being raised in controlled conditions and stocked in the natural environment.

No animal lives totally isolated from others in an aquatic environment. When certain baitfish disappear, it affects game fish dependent on that bait. If the environment is altered so that juveniles have difficulty surviving, the stocks of adult fish dwindle very quickly. The balance of nature is always fragile.

Every person who teaches fishing to others should make students aware of the need for catch and release. Those who already understand the critical concept of protecting the habitat and resource should share this knowledge with others. Many fishermen simply do not think that what they do individually will have any effect on the system. They are obviously wrong and should be shown how their impact is cumulative. Education holds the key to the future. Without a knowledgeable fishing public battling to maintain quality, there will be even less for future generations.

Respect for Others

Fishermen are often referred to as "sportsmen." The connotation is that they conduct themselves in a gentlemanly manner afield, showing respect for others and following an exemplary code of ethics. It is not unusual for a sportsman to give every advantage on the water to his partner. He may even suggest that the other person fish what he perceives to be better water or to take the prime position in the boat.

This attitude of concern should go beyond fishing partners and close friends. There are unwritten rules of respect for other anglers. If someone is fishing a dry fly and working upstream, another angler does not enter the water 50-feet above the first and begin fishing. Each person should be given adequate room to fish undisturbed. If someone moves out of a spot to fight a fish, he has a right to come back when he has landed or lost his quarry. When a boat is working an area, another boat does not move in ahead or crowd the first one for there are certain proprietary rights.

Etiquette on the water is no different than anywhere else. It is the age-old rule of treating others as one would want to be treated. When one shows respect for others, it makes the day much more pleasant for everybody. Fishing is not relaxing when anglers aggravate each other over inconsequential matters.

Fishermen who ignore good manners in the field make it difficult or impossible for those who follow to gain access to the land. Most farmers and landowners are reasonable people, willing to host those who behave as guests. They expect visitors to leave everything the way they found it. If a fisherman has to open a closed gate to gain access, the gate must be shut behind him so farm animals cannot escape.

No one enters another's house without asking. Seeking permission to fish private waters to gain access to public waters shows respect and courtesy. It only takes a few minutes to knock on the door to ask if fishing is allowed. Perhaps the owner would like a fish or two for dinner. Basic courtesy and respect insure that the land will be open next week and next year. Posted lands are the result of illegal trespass and littering or damage of private property. Owners may overlook aggravations a few times, but when problems persist, the gates are locked.

Nothing is more frustrating to a bass fisherman than water skiers zigzagging through prime habitat. Trout anglers shudder at the sight of hikers or campers marring the banks of productive water. Sightseers zipping across tarpon territory in high powered boats anger fishermen stalking the fish with fly rods in hand. These and countless other encounters with non-fishing users of aquatic resources create friction and conflict.

The fisherman considers the water to be his domain and frowns on what he considers unauthorized intrusion. Non-fishing folks believe they are merely enjoying the great outdoors and that there is certainly enough room for everybody. Few of these enthusiastic souls would purposely or knowingly ignore the needs of an angler and ruin his day. The problem centers on the fact that non-fishermen are frequently unaware of what is involved in fishing.

The resource should be available to everyone and must be shared. Angry confrontations seldom solve the problem. Education can help people comprehend the requirements of fishermen and can aid fishermen understand what other outdoor users need.

Every boat should have a container for litter. Anglers who walk into a fishing spot should carry out everything carried in, including candy wrappers, empty cans, plastic bags, and even cigarette filters. A great many sportsman now pick up litter left by others, which is a good idea.

Too often, recreationists who find beautiful flowers or plants growing in the wild pick the flowers or dig the plants to take home. However, it is unfair to others to mar the beauty of an area for those who will come later.

Familiarity with Letter and Intent of Fishing Regulations

The adage that "rules were meant to be broken" has no place in the outdoors. Fishing regulations have been established to protect and spread the resource for more people. It is vital for those who fish to be intimately familiar with all restrictions relating to habitat and different species. Ignorance of the law is no excuse.

If there are fishing seasons, these must be learned. They have been established either to protect the fish during spawning seasons or as a method for limiting the catch on heavily fished waters. Creel limits are tailored to keep people from taking too many fish at one time. This spreads the resource so everyone can enjoy a share of it. At the same time, restricting the catch protects the stock of a given species both in specific bodies of water and in total.

Size limits are aimed at allowing fish to grow to spawning size before they are caught. The rationale is that if each fish spawns at least once, it will help the stock remain adequate. Of course, this does not take diminishing habitat into account, but size limits are a vital part of fisheries management.

Some states have basic regulations that apply from border to border. Other states vary seasons, size and creel limits from waterway to waterway or area to area. Check regulations carefully.

A few anglers bend the rules at every opportunity. If a fish is too small, some people clean it on the spot, hoping that a law enforcement officer will not be able to tell the length of the whole fish. Some state laws prevent fish from being cleaned on the water so that size can be ascertained.

Some so-called sportsmen go out in the morning, catch a limit, and immediately take it home or hide it in a cooler in their car. Then, they return to catch another limit. Such an irresponsible attitude is not only illegal, but affects everyone who shares the resource.

An increasing number of states require a basic fishing license plus a special stamp for fish such as trout, salmon, and striped bass. These stamps generate funds to support hatchery and fish management practices related to that species.

More and more coastal states are also requiring a salt water license. Licensing serves many purposes. Managers get an accurate count of participants and the revenues can be used to support the resource. Without these much-needed funds, the support of the fishery would be meager, at best.

Sportsmen Involvement and Responsibility

The concept of letting someone else worry about the resource has little meaning if the resource is to be protected and conserved. Every user must share part of the load and the burden. More and more aquatic habitat is being lost every year, carrying capacities are dwindling, and more people are turning to fishing.

Increasing pressure and demand matched against decreasing supply does not hold well for the future. Business interests with political clout often receive a green light to turn an aquatic resource into an area for shoreside homes or other business ventures and in the process, destroy the resource.

Police enforce laws and protect people from criminal actions. It is easy to become complacent and not even want to know what is happening. Unfortunately, there are very few watchdogs when it comes to the environment and the resources. Frequently, specific laws must be thrust under the noses of the judiciary before an attempt is made to enforce them. Few people wander around looking for polluters so they can blow the whistle. If prime waterway is about to be channelized or subjected to the developer's earth moving machinery, only a handful of concerned citizens stand tall and shout. Many warnings go unheeded until it is too late.

About 60 million Americans fish. However, politicians know that anglers are part of some unknown silent majority and that they never seem to pull on the oars at the same time. These people could form one of the greatest political forces ever known.

Legislative Actions

Governmental bodies on every level are becoming increasingly involved in ecologically-based legislation. Many elected officials are not well-versed on these subjects, and even those who are want to take the pulse of their constituency before committing to one side or the other. That is where involvement by sportsmen can pay dividends.

No one is closer to the scene than the actual users of a resource. Fishermen know what is happening to their favorite waters. Making one's views known to those who will vote on legislation is vital. It is far too easy to shirk this responsibility, expecting others to pick up the standard and carry it into battle.

Contacts with legislators should be meaningful. Irate behavior is far less convincing than simply presenting facts in a logical manner. Letters should be short, to the point, and deal with the issues. Every fisherman needs to get involved and to accept a share of the responsibility for protecting the resource.

Organizations

Joining an organization is an excellent means for becoming involved in resource projects. Many groups have taken a leadership position and are exceptionally aggressive in their approach. Trout fishing clubs, for example, work on stream improvement, challenge polluters, and take an active position on current issues.

Organizations exist locally as well as on county, state, regional, and national levels. One merely has to select those of interest and join. Some are strictly for fishing, while others concern themselves with the environment and conservation in general. The Coastal Conservation Association (CCA) is a case in point. Started in Texas to save the redfish and seatrout, it has expanded to several coastal states and now must be considered a strong faction on the side of the sportsman.

Several influential groups interact on a national level. These include the National Wildlife Federation, the Sport Fishing Institute, Audubon Society, Sierra Club, Izaak Walton League, and the Nature Conservancy. These organizations have strong contacts in Washington, D.C., and serve as watchdogs for the total environment.

Individual members lend financial support to these national groups and add to the total membership. That impresses legislators and the groups have more clout. For hands-on involvement, however, local or state groups offer more opportunity. One must consider an area of concern and then join the group or groups that best serve those needs. Few people have the time to work diligently for several organizations, so it is wise to give a few total support.

Personal Actions

One way streets do not go very far. Simply taking from a resource without putting something back into it is a short-sighted view that produces damaging consequences. To paraphrase an old saying, one does not kill the goose that lays the golden egg. Standing idly by and watching an aquatic ecosystem disintegrate has the same connotation. Fishermen cannot let others take away the waters and the stocks of fish if the sport is to continue.

Involvement and responsibility trigger personal action. Money for a "war chest" is one way of helping, but there is no substitute for people giving of their time and expertise. Each angler must decide what he is willing to do and then volunteer his service.

Above all, every fisherman has the responsibility to be well-informed on current issues affecting the sport and the aquatic ecosystems that make it possible. This should be done on a continuing basis by reading newspapers, magazines, books, and listening to radio and television. Dissemination of information is better today than ever, and almost all pertinent issues are covered by the press.

Why Fishing Is A Good Environmental Sport and Recreation

There is no sport like fishing. It has universal appeal and is not limited by age, sex, race, education or financial means. Anyone can fish and have fun doing it even though the degree of participation may be tailored to individual preference. It might be a casual pasttime or a serious pursuit. One can fish from the bank, from mid-stream, or from the comfort of a boat, and handicapped anglers can participate as well.

Learning to catch fish is relatively easy and there are greater advances in tackle today than ever before. There is a phase of fishing that matches every budget and, as President Herbert Hoover once said, "In the eyes of a fish, everyone is equal."

Whether it is a pond in a city park, a remote stream flowing through the wilderness, or the shore of a mighty ocean, water has a soothing effect on people. Being near the water is relaxing and promotes a feeling of well-being. Fishing also encompasses an unknown factor. One is never certain when he will catch a fish or what size the fish will be. Hope springs eternal in the hearts of fishermen.

There is no better way to learn about nature and to be part of it than through fishing. Anglers have an excellent opportunity to observe all types of wild creatures and to marvel at the mysteries of nature.

Watching the first fingers of dawn claw across a dark sky is a marvelous experience. Seeing the sun come up across the water or dip below the horizon as it sets is equally wonderful. There are trees and birds, gurgling streams, crashing surf, and the violent eruption of a game fish as it engulfs its prey at the surface. These sights and sounds cannot be duplicated in every-day life. Fishing is more than a method to gather food. It is an adventure and a unique recreational pursuit.

Career Opportunities

Many anglers and outdoor enthusiasts would like to work in a field closely associated with fishing. Fortunately, many options are available to men and women in a variety of fields, even in these highly job-competitive times.

1. *Fisheries Biologist*—Fisheries biologists need an undergraduate college degree and most positions now require advanced degrees, such as a Masters or PhD. As a general rule, the higher the degree, the greater the chance of advancement and promotion. Fisheries biologists must have an interest in biology and should choose life sciences in high school and aquatic biology and related college courses. Many job opportunities are with state or federal government agencies, although local government or private employers (e.g. environmental consulting), also offer positions. Fisheries biologists frequently work in the field, gathering data and samplings for later lab and statistical analysis. These data assist in managing and conserving fish and the aquatic environment, along with establishing baseline fishery data. Interpretation and application of this information requires a thorough understanding of fish and their support systems, as well as the interests of the angler and other user groups. These data are utilized for the development of short and long-term fisheries programs and for the enactment of fisheries laws and regulations. Biologists spend considerable time in the office or laboratory analyzing field data, and writing reports, as well as talking with the public. The work of fisheries biologists benefits the resource and enhances sport fishing.

2. *Natural Resources Police*—Once called "fish and game wardens," today's outdoor police have additional responsibilities, including not only enforcement of game and fish laws, but also the enforcement of environmental and pollution laws.

All states have natural resources police to enforce state statutes. Federal law enforcement personnel enforce federal regulations. Most federal agents are involved with game laws concerning waterfowl (migratory species), species protected by treaty, endangered and exotic species, or coastal fisheries rather than other game/fish concerns. Game and fish laws are usually the province of state and local jurisdictions.

Most states require a college degree in fisheries or law enforcement and duties and opportunities vary by area. Some states have police that cover both fish and game; others have separate police for game and fish departments. They may require training in wildlife and fisheries.

Careerists will spend long hours in the field, sometimes under adverse weather conditions. They must work at times when others are actively fishing and hunting; be interested in dealing with the public on a regular basis; and have a steady temperament for testimony in court cases and for dealing with the public.

3. *Teacher*—Biology, ecology, environmental and fisheries teachers on the high school, college and postgraduate level come in active contact with the aquatic environment. This contact can include teaching, both in the classroom and in the field, or in field or lab research. Most teaching positions, particularly on college and postgraduate levels, involve all of these.

The requirements include a college or advanced degree in biology and teaching methods, plus an interest and ability to motivate others along with the patience and desire to work with youth. Currently, there is a need for high school teachers but little demand for teachers at the college level. Available positions are awarded to those most highly qualified.

4. *Conservation Representative*—Many non-profit groups are involved in outdoor and fisheries related conservation efforts. Notable examples include the Izaak Walton League of America, the National Wildlife Federation, Trout Unlimited, and the Sport Fishing Institute. Many similar groups are involved with conservation of special areas and species or are working to preserve certain areas. These groups have representatives who study laws and regulations, coordinate lobbying efforts, represent fishing interests to Congress and state legislatures, plan volunteer work, and publish newsletters. Smaller groups utilize volunteer or part-time employees or perhaps only pay their expenses. Those interested in a career can begin with an interest in some specific cause, but most are fisheries professionals, work for local efforts and, in time, become involved on a full or parttime paying basis. An advanced degree in fisheries or resource management plus work experience is often necessary today.

5. *Tackle Shop Dealer*—Tackle shop owners are in a field related to fishing, but their busiest times will come when others are fishing. Most tackle shop owners take their "weekends" during the week since they stay open on Saturdays, Sundays and holidays.

Tackle shop work involves long hours. Those selling live bait open as early as 4 A.M. and close as late as 9 P.M. each day. Requirements include a good business background and experience, extensive knowledge about fishing and tackle, and an interest in serving the public.

6. *Charter Boat Captain*—Charter captains are similar to fishing guides, but usually operate larger boats holding up to six paying anglers (charter boat license) or more (party boat license). Charter boat captains must be licensed and are concentrated in salt water areas and on the Great Lakes. Charter boats range from 20 to 55 feet, or larger for party boats. Some captains own their own craft while others operate boats for private or corporate owners.

7. *Commercial Fisherman*—Commercial fishermen harvest fish to sell for food. They work with nets, traps, and long lines with heavy gear, often in rough and inclement conditions. The hours can be long and the work strenuous and dangerous. The pay can be high when the fishing is good, but it is often seasonal and subject to outside influences such as government regulations, foreign imports, loss of fish stocks, pollution, equipment breakdown, and poor economic conditions.

8. *Fishing Tackle Manufacturer*—In 1987 U.S. tackle sales were estimated at $1.4 billion at retail, with future growth projected at a rate of 5–10% annually. In the past, entrepreneurs often started tackle companies with little financial backing. They worked hard to produce local sales and eventually grew large enough to distribute their products nationally. Today some manufacturers still start operations on a shoestring and succeed, especially when they have unique products or specialty fishing equipment.

Since lower manufacturing costs have resulted in more tackle made abroad and imported into the U.S., some of the best career opportunities available in the industry today are in areas related to the sales promotion and marketing of fishing tackle. Interest and experience in these areas, especially when combined with financial, general business or accounting courses will best prepare an individual for a career in today's fishing tackle industry.

9. *Manufacturer's Sales Representative*—Manufacturers are dependent upon local or regional salesmen to sell their product to dealers and distributors. These are the outlets through which anglers purchase fishing tackle. These "reps," as they are often called, work for firms that represent a number of noncompeting companies. For example, a rep firm could carry one brand of fishing line, another's lures, and another's paddles and oars while carrying a rod and reel company's products and a line of outdoor clothing.

Individual reps are often responsible for covering a large geographic area, up to several states in some cases, thus must travel extensively. They must enjoy people, have good selling ability, and know fishing and fishing tackle.

10. *Fishing Guide*—Fishing guides provide boats, tackle and their experience and knowledge when taking paying anglers fishing. A fishing guide must have the ability to get along with people, a desire to take anglers to fishing areas and help them catch fish, a willingness to forego fishing while helping others succeed and the necessary fishing and boating equipment. Many guides work parttime as a supplement to another line of work. Teachers may guide in the summer and firemen on days off, while retirees may guide to supplement retirement benefits.

11. *Publisher*—Publishers are responsible for producing magazines, newspapers, newsletters, fishing annuals, regional and local guide books, and similar products. They may edit, or sell ads, but in addition they are often in charge of the total publication, including editorial and advertising staffs. They also coordinate the actual printing, distribution, and subscriptions/sales of their product. A publisher must have knowledge of editing, ad sales, printing costs, subscriptions, newsstand sales, and possess a comprehensive business background.

12. *Outdoor Writer*—Outdoor writers communicate about outdoor sports and activities, including fresh and salt water fishing, hunting, camping, boating, backpacking, white water rafting, canoeing, bird watching, photography, skiing, and snowmobiling.

Many colleges have schools or offer courses or majors in journalism. Most writers in this field have a love of the outdoors and start by writing and selling columns, features and articles to magazines and smaller newspapers. Some progress to become full-time outdoor writers or communicators with large newspapers, magazines, radio or TV shows, or as full-time free lancers working in a variety of media.

Those interested in pursuing this career possibility should have a solid journalism background and excellent writing skills. A degree in journalism or English is very helpful.

Writers should be thoroughly conversant with their chosen field of the outdoors. Writers spend much time in the field fishing and hunting, but may utilize a network of biologists, managers, and other resource persons with whom they can check technical points. They must take precise notes and compose good photos. In addition, much time is spent preparing articles and doing darkroom and photo work.

13. *Tournament Angler*—Bass fishermen are well aware of the growing number of professional anglers. A very few of these anglers make a sufficient full-time living through tournament winnings and the endorsement of tackle for manufacturer sponsors. Many are parttime tournament anglers, working regular jobs and going to tournaments on weekends. A total commitment is required for consistent angling success. The lifestyle involves extensive travel. The ability to speak well is important in obtaining tackle company sponsorship.

14. *Other Related Fields*—Aquatic scientists for business, industry, and consulting firms provide many professional opportunities. Roughly 15% of working fisheries biologists and scientists are now employed in these areas.

Tour guides for local, state, and national parks and recreation areas, recreation specialists, outdoor interpretative specialists, research biologists, and environmental educators are other careers which may interest the outdoors enthusiast.

Glossary

Accuracy One component of casting that involves the ability to cast a plug or bait to a predetermined spot.

Acid Rain Rain that is acidic from sulphur compounds in the air, primarily originating from coal burning factories and auto emissions. While controversial, it is thought to be damaging to waterways, destroying lakes and streams, primarily in the northeast and Canada.

Action Describes how a rod bends. Rods that have most of the bend in the tip end are called fast action while rods that bend evenly throughout their length are labeled parabolic.

Adaptation The characteristic of a species to accommodate its basic nature to its environment to satisfy its basic needs of reproduction, comfort (security), and food.

Aerator An electric air pump used to maintain oxygen levels in live wells or bait containers.

Algae Simple, photosynthetic plants with unicellular organs of reproduction.

American Spinning Reel A standard spincast reel.

Anadromous Any species of fish that lives in salt water and spawns in fresh water. Species include salmon, shad, perch, striped bass.

Antireverse Lever A lever or knob that prevents the reel handles from turning backwards as a fish tries to take line.

Backing A soft, strong fishing line, such as braided Dacron, that is wound onto a fly reel before the fly line is added.

Backlash Line tangled on a casting reel as a result of a cast made when the spool continues to revolve after the line has stopped going off the reel.

Bail A wire half-round device that spools the line onto an open face spinning reel

Bail Roller A small roller bearing-like device on one end of the bail over which line rolls when it is retrieved.

Bail Spring A small spring used to operate a bail on a spinning reel.

Bait-Casting Name given to casting equipment that uses a bait-casting reel. The reel is also called a "level-wind" reel.

Barb The spur found on the point of most fish hooks to lessen the chance of a fish escaping.

Barbel A whisker-like projection from the jaws of some fish, such as carp or catfish. They help the fish smell and feel.

Bass Boat A boat designed and built for bass fishing.

Bass Bug A floating, hard bodied bug, usually made of cork or plastic and tied with feathers, and designed to take bass or panfish. Some small bugs are called panfish bugs.

Blank The basic shaft of fiberglass or graphite or other rod material on which a rod is built. All are tapered, have varying power and action, and designed for a specific style of fishing. Guides, tip tops, handles and reel seats are added.

Bobber Same as a float, used to float on the surface and suspend a rigging or terminal tackle, usually consisting of a baited hook and sinker. Sometimes called a float or cork.

Bridge Gaff A gaff that is more like a grappling hook attached to a line, used to drop into the water from a bridge or pier to land large fish.

Buzzbait A bass fishing lure designed to run on the surface, creating a surface disturbance with a large blade.

Cane Pole Equipment that employs a long, slender rod and no reel. Cane poles are sometimes called "bank poles."

Catadromous A species of fish that lives in fresh water and spawns in salt water, such as eels.

Catfish A group of scaleless fish named for the long barbels around their mouth that resemble "cat whiskers."

Chart A "map" of water areas. Charts pinpoint shoals, wrecks, rocks, shorelines, shallows, and other danger areas.

Charter Boat A boat that is available for charter and can take out several passengers.

Chumming A method of scattering small bits of food into the water to attract and hold fish in an area where they can be caught on bait or with lures.

Class Line A fishing line which tests less than the nominal strength listed on the label. Used when a fish is to be entered into a certain IGFA record keeping category.

Cone A device found on spin-casting reels that prevents the line from springing off the spool during the cast. It also protects the spool from dirt and grit. It is also called a "nose cone," or "reel cover."

Conservation The wise use without waste of a natural resource.

Cove A small bay or inlet in a body of water.

Crankbait A term for what is commonly called a plug. Typically these are plastic lures that are designed to dive under the water's surface.

Creel A fish basket or personal fish carrier used to carry fish when fishing on or near shore.

Creel Limit A term used by some fisheries agencies to indicate the number of fish, by species, that can be legally caught in one day.

Current Any movement of water, whether caused by tides, ocean water movements, or flowing water in rivers and streams.

Depth Finder Also called fish finders and sonar they are essentially sonar devices that signal the bottom and record it on a flashing dial, LCD screen, or graph paper.

Detritus Particles of rock or other material worn away from a mass, by action of water; disintegrated material; debris.

Dissolved Oxygen (DO): The oxygen utilized by fish which is put into water by forces such as wind, plants, microorganisms, etc.

DNR Frequently used abbreviation for the Department of Natural Resources, the agency in many states responsible for fisheries management and conservation.

Dorsal Fin A fin located on the back or uppermost part of a fish.

Double Taper A type of fly line that has a thick, long center portion (belly) with tapers at both ends.

Downrigger A fishing device used on boats that allows fishing very deep with light tackle while trolling. It consists of a reel of heavy line or cable, a heavy weight to keep the cable taut, and release clips into which the fishing line is fastened and then released when a fish hits. Allows the angler to determine the depth to troll the lures.

Drag Anchor An anchor used for fishing in currents. The anchor is designed to slip allowing the boat to move with the current. A length of heavy chain is often used.

Drag Knob The knob that allows the adjustment of the reel's drag pressure.

Drag System A system of soft and hard washers in any reel that serve as a braking mechanism to slow a fish as it takes line off of a reel. Drag pressure is usually set to 1/4 to 1/3 of the line test.

Dry Fly A fishing fly tied to stiff hackle materials that together with a special dressing, allows it to float and imitate an adult stage (dun or spinner) of a stream aquatic insect such as a may fly, caddis fly, or stone fly.

Ecology The branch of biology dealing with the relations between organisms and their environment.

Epilimnion The warm layer of water above the thermocline.

Erosion The process by which the surface of the earth is being constantly worn away. The most important elements responsible for erosion are rivers and streams, wind, waves, and glaciers.

Ethical Judging behavior right or wrong based on a set of values or opinions.

Eutrophic Lake classificaton or lake type used to describe bodies of water characterized by high levels of nutrients in proportion to their total volume of water.

Eye The part of fish hook where line is attached or where the hook is attached to a lure.

Fillet 1. The act of removing the boneless, edible portion of the fish. Filleting involves cutting out the flesh or muscle and then (usually) skinning the fish to leave a boneless strip of fish. 2. The portion of the fish cut out and ready to cook.

Fillet Knife A long-bladed, thin, flexible knife used to fillet fish.

Fingerling A juvenile fish, usually about several inches, or one finger length, thus the name.

Flasher A type of depth finder that records information on depth and bottom structure as blips of light on a circular dial.

Flipping A method of fishing, primarily for largemouth bass, that involves swinging the rod so as to drop the lure or bait into a selected spot where fish are thought to lie.

Float See bobber.

Float Plan A plan which should be filed by every boater with a land-based representative on each trip, disclosing the plans for the day and expected time of return. Important for authorities should an emergency arise.

Fly An artificial lure tied on a hook and made of fur, feathers, tinsel, wool, synthetic dubbing, thread, etc., and designed to be cast with a fly fishing outfit.

Fly Tying The craft of tying flies, i.e., wrapping thread around fly tying hooks to secure the materials to make them imitative of insects, bugs, and aquatic insects.

Food Chain Chain of organisms existing in any natural community through which energy is transferred. Each link in the chain feeds on and obtains energy from the one preceding it and it in turn is eaten by and provides energy for the one following it. The food chains in a community make up the food cycle or food web.

Fry 1. A method of cooking fish in hot oil 2. Small juvenile fish that have just hatched out of the egg and up to several inches long (at which point they become fingerlings).

Gaff A "j" shaped, barbless hook on a long handle used to hook large fish to help land them.

Gig Like a harpoon, but with several barbed points and used primarily to capture small fish.

Gill An arch-like breathing organ located behind the gill cover on a fish's head.

Gill Net A commercially used net that has a mesh size designed to catch fish by the gills, preventing them from backing away and escaping. Different mesh sizes are used for different fish species and sizes.

Gorge A primitive type of hook consisting of a double sharpened short stick or bone, tied in the center, and holding bait. When eaten by a fish, the gorge became lodged in the fish's throat or gullet.

Gradient The rate at which a road, river channel, or stream, etc., rises or falls.

Graph Recorder Depth finder that records all information on a roll of graph paper.

Grip That part of the rod which is held by the angler. Usually made of cork or synthetic material.

Guides Circular rings made of metal or synthetic materials (aluminum oxide, silicone carbide, etc.) attached to the rod blank through which the line travels.

Habitat The type of place where a species of fish lives.

Hackle Pliers Special spring operated pliers designed to hold hackle when tying flies, to enable wrapping the hackle around the hook shank.

Handle The part of the reel which is gripped and turned to retrieve line.

Harpoon A pointed, barbed spear-like device for spearing and capturing fish.

Hip Boots Rubber or synthetic waterproof boots that come up to the hips (crotch) and are used by wading anglers to get out from shore.

Hook Keeper A small device, usually made of wire, to hold a lure or hook when the rod is not being used.

Hypothermia Rapid and abnormal chilling of the body to the point where the body cannot regain warmth under existing conditions. Thought of as a condition that occurs only in cold weather, it can also occur in mild and even warm weather. Victims must be warmed by special means with special procedures to prevent greater or long-term damage or death.

I.G.F.A. Abbreviation for the International Game Fish Association, an organization devoted to keeping records on fish catches and supporting sportfishing ventures.

Ice Auger A large ice drill used to cut a hole in the ice for fishing.

Ice Spud A long heavy chisel-like device used to chisel a hole in ice for fishing.

Ichthyology The branch of zoology that deals with fish, their classification, structure, habits, and life history.

Impoundment A natural or artificial place where water is collected and stored for use. See reservoir.

Jig Lead molded onto a special jig hook. Tail material of rubber, feathers or fur and various combinations of these may be tied onto the hook shank.

Jigging Fishing using an up-and-down motion with the rod.

John Boat A small, usually aluminum, square-bow boat designed for quiet water or river fishing. Range in length from 10–16 feet.

Keel Fly A fly tied on a special bend shank keel hook that allows tying so that the fly is tied with the hook point up, the wing tied to protect and make the point weedless. Designed for fishing in weedy areas.

Lake Classifications Broad categories of lake types; oligotrophic (infertile), mesotrophic (fertile), eutrophic (very fertile).

Lateral Line System System of sense organs present in aquatic vertebrates (fish) in pores or canals arranged in a line down each side of the body and in complicated pattern of lines on the head. It detects pressure changes including vibrations (low frequency sounds) in water.

LCD Recorder Depth finder or sonar which records the information on an LCD screen, much like the material used in digital watch faces.

Leader Any material that is used between the main line and the lure or hook. Can be monofilament, single strand wire, braided wire or cable. Can be lighter or heavier than the main fishing line. Often used for toothy fish to prevent them from breaking or cutting off.

Level Wind The part of a bait-casting reel that ensures the line is rewound evenly onto the spool.

Live-Well An aerated container, built into a boat for storing fish and keeping them alive.

Lob Cast A slow cast used when fishing bait so as not to throw the bait off the hook during the cast.

Lure Name for any artificial bait used to attract fish.

Map A drawing of features on land (as opposed to a chart which shows features on water). Maps are useful in finding streams and access to rivers and lakes for anglers. Topographical maps are useful since they show contour elevations and various natural features.

Marl A mixture of clay with carbonate of lime, the latter being present in considerable quantity.

Monofilament Line A single, strong synthetic fiber used for fishing line.

Moraine A mass of rocks, sand, etc., deposited by a glacier.

Natural Bait Bait that is not artificial, is organic, and common to fish's habitat.

Net A mesh woven material used to capture fish. Large nets are used for commercial fishing; small nets by anglers to land fish caught on sporting tackle.

Nose Cone See cone.

Nymph A larval phase of an aquatic insect. Also, a fly tied to imitate such, used primarily when trout fishing.

Olfactory Nerves Nerves that allow for the sense of smell.

Oligotrophic Lake classification used to describe bodies of water characterized by low amounts of nutrients in proportion to their total volume of water.

Open-Face A spinning reel that has the spool uncovered or exposed.

Outrigger A long pole that extends from the side of a fishing boat (usually two are used—one on each side of offshore boats) and used with lines and release clips to allow greater variety in trolling.

Oxygen Necessary for all life including fish life. Found dissolved in water and taken in by fish through the gills.

Panfish A classification given to small fish such as bluegill, sunfish, and crappie.

Pawl A pivoted bar arranged to catch the teeth of a rachet wheel to prevent backward movement.

PFD An abbreviation for Personal Flotation Device, the technical term for a life vest.

pH The hydrogen ion content, or the acidity or alkalinity of any substance. In water, most fish find neutral pH most comfortable. Based on a sale of 0 to 14, neutral being in the middle. A low pH means acidic water, high pH is caustic or alkaline. Either condition, in the extreme, can harm fish.

Photosynthesis In green plants synthesis of organic compounds from water and carbon dioxide using energy absorbed by chlorophyll from sunlight.

Planer A device that will cause a fishing line to angle down and take a lure far deeper than it would normally run.

Population Density The number or mass of individuals of a given population occupying a unit of space. For example, the number of bass per acre.

Practice Plug A special no-hook hard rubber or plastic weight used to practice casting.

Predator A fish that feeds on other fish.

Predator-Prey An interdependence between a species and an accessible and suitable forage.

Pumping A method of fighting fish that involves raising the rod to pull the fish closer, and then gaining line by reeling as the rod is lowered.

Push Button A lever or knob on a spincast reel. Pressing the push botton holds the line in place until pressure is released, at which time the line and lure are cast.

Quarry Prey; anything hunted.

Reading Water The ability to look at a body of water and select the most likely spots which would hold fish.

Redd Nest dug for spawning.

Reel Body The part of the reel that holds the gears and other controls.

Reel Foot That portion of the reel used to hold the reel on the rod. It fits on and is gripped by the reel seat.

Reel Seat That part of a rod designed to securely grip a reel by the reel foot.

Reservoir Impoundment. An artificial place where water is collected and stored for use.

Retrieve The act of rewinding line onto a reel spool.

Rigging The process of attaching a lure or bait for a particular situation or species of fish.

Rod Butt The end of the rod handle.

Sand Spike A pointed hollow tube, usually of aluminum or plastic, designed to stick upright in sand to hold a surf rod.

Scale 1. A chitinous covering plate on a fish. 2. A method (scaling) of removing the scales from a fish for cooking and eating. 3. A gauge used to weigh fish.

School (of fish) A number of fish of a species that are grouped together for mutual advantage.

Scoring A method of preparing fish by making narrow cuts almost all the way through, which allows hot oil to cook up the small bones.

Season The period of time during a year that a particular species of fish may be harvested.

Sedimentation The deposition or accumulation of sediment.

Setting the Hook The process of embedding a hook in a fish's mouth.

Shaft Often referred to as the shaft extending from the body of the reel and surmounted with the handles. Can also refer to the main geared shaft which extends through an open faced spinning reel.

Shank The longest part of most fish hooks, between the eye and the bend of the hook.

Shock Leader A leader that is heavier line test than the main fishing line and designed to withstand the shock of casting or to prevent cutoff and breakoff of toothy fish.

Side Planer A planer which runs to the side of the boat for trolling.

Sinker A weight used to get a lure or bait down deeper into the water. Many types are used depending upon the purpose.

Skirted Spool A type of spool found on open face spinning reels where a flange or extension extends from the rear of the spool to cover the cup and spool housing. Skirted reel spools usually allow for longer casts than cupped spools.

Slough A swampy place; marshy inlet.

Snag An underwater structure that tends to cause a lure or bait to become hung up.

Snagging A method of catching fish where the person casts a heavy sinker and large treble hook with no bait. The fisherman tries to hook the body of a fish by making strong pulls on the rod.

Snap A small fishing terminal fastener that works like a dog leash snap to fasten lures and rigs to the fishing line, or to connect terminal gear.

Snap Swivel Like a snap, but with the addition of a swivel to help prevent line twist.

Snelled Hook A hook that is pre-tied with a short length leader.

Sonar Same as depth finder.

Spaghetti Tag A long, thin tag, resembling spaghetti used to mark fish for migration and other studies.

Spawning Run The movement of fish to a location for spawning.

Species A biological classification of plants and animals.

Spincast Lures Lures of all types that are fished with spincast tackle.

Spinner A standard type lure that consists of a rotating blade on a shaft that holds a body or beads and ends with a hook.

Spinnerbait A lure consisting of a weighted head and hook (like a jig) molded onto a right angle safety pin wire that holds a blade or blades. Sizes range from small to large, with single and double-blade styles.

Spinning Lures Lures of all types that are fished with spinning tackle.

Spool Device to hold the line on any reel.

Spoon A lure made of sheet metal and designed to imitate a baitfish. Basic types include jigging spoons designed to be worked vertically; trolling spoons; and weedless spoons with a weed guard.

Sport Fishing Fishing for recreation and not for profit or commercial reasons.

Star Drag A drag system consisting of several layers of soft and hard washers in a reel and controlled by a star-shaped wheel. Originally found on salt water reels, but today used on casting and some spincast reels.

Steak A chunk of fish that is made by cutting fish into steaks by transverse cuts through the body. Reserved for larger fish.

Stickbait A floating plug or artificial lure of wood or plastic that has no action and must be manipulated by the angler.

Still Fishing A method of fishing whereby the bait is cast to a likely spot and the angler waits for the fish to bite.

Streamer A type of fly tied to a long shank hook and typically using feathers for the "wing" and designed to imitate a stream minnow.

Strike The point at which a fish hits or engulfs a lure. Also a noun as "to strike" a fish to set the hook.

Strike Drag A heavier than normal drag often set to strike a fish and drive the hook in the fish. Most often used with the drag system on offshore reels.

Structure A term often used by anglers to designate any type of object or cover attractive to fish. Structure that fish relate to includes stumps, rock piles, log jams, piers, docks, boat houses, channel markers, points of land, etc.

Subsistence Fishing Fishing often ascribed to primitive peoples in which other than sporting means are used to gather fish specifically for food.

Substrate A layer lying under another; the base or matter upon which an organism develops.

Suspended Fish Fish which are hovering considerably above the bottom in open water.

Swivel A small fastener consisting of two eyes with a central barrel or swiveling portion. Designed for fastening lines and line/leader combinations to help prevent line twist through lure action.

Tack A slanting or zig-zag course against the wind or waves.

Tackle A name given to fishing equipment or gear.

Tackle Balance A term used to describe how a rod, reel, line, and lure or bait should be matched. Reel size, rod stiffness, line strength, lure weight, and fish size must all be matched for proper casting and fish fighting.

Tackle Box A portable storage unit used to organize and transport fishing tackle items.

Tailer A fish landing device that works like a noose to snare fish by the tail.

Tapered Leader A leader primarily used in fly fishing that is thick at the line attachment and tapers to a thinner end, or tippet, at the end where the fly is tied.

Taxidermy A method by which fish are preserved for mounting as a trophy. Many methods are used including fiberglass mounts, freeze drying and traditional "stuffing" methods.

Terminal Tackle The hooks, weights, swivels, and other fishing tackle attached on or near the end of your fishing line.

Test Line A line guaranteed by the manufacturer to test at least the nominal rating on the label. See also Class Line.

Thermocline Temperature stratification in a body of water. Specifically, the layer of water where temperature changes at least one half a degree per foot of depth.

Tight-Line Fishing A method of fishing live or natural bait whereby the angler lets the sinker take the bait down and then tightens the line when the bait is on the bottom.

Tippet The small, front section of a tapered leader to which the lure is attached.

Tournament A fishing contest with places based on weight of fish or total catch. Many tournaments today are release tournaments in which the fish are released after being weighed.

Tourniquet A device for stopping bleeding by compressing a blood vessel, such as a bandage tightened by twisting with a stick.

Trolling A method by which lures or bait are trailed on the end of fishing line behind a moving boat. This method makes it possible to present baits and lures over a wide area.

Turbid Not clear; muddy; cloudy.

Turnover Period A very brief period of the fish cycle when a lake is in turmoil. A mixing or "turning over" of the water takes place as cold water on the surface settles and warmer water from below rises. This turnover homogenizes lakes that have stratified (layered according to water temperature) in summer and reoxygenates the water.

Ultra-light A name given to casting equipment that is reduced in size for casting small, lightweight lures.

Viscosity The resistance of a fluid to the motion of its molecules among themselves; thick; sticky.

Waders Long rubberized or synthetic boots that extend up to the mid-chest or armpit area for wading in deep waters while fishing. Allow for deeper wading than hip boots.

Water Pollution The contamination of water. Water pollution often limits the amount of fish in a body of water or eliminates them entirely.

Watershed The region drained by one river system.

Weedless A hook or lure that tends to pass through aquatic vegetation without picking any up.

Weight Forward Taper A type of fly line in which the heavy thick "belly" portion is towards the front, with a front taper leading to the end where the leader is attached and a rear taper leading to a long running line that is thin and takes little room on the reel.

Weir A channel or fencing of stones or sticks placed in the water to channel or guide fish into an area where they can be captured.

Wet Fly A fly that can imitate an aquatic or land insect and that sinks in the water. Most are made of soft water absorbent materials.

Wrapping Thread or other material wound around the rod and guide to secure the guide to the rod.

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APPENDIX
A

Sources of Additional Information or Assistance

FEDERAL AGENCIES

Department of Agriculture
Extension Service
14th St. and Jefferson Dr., SW
Washington, DC 20250

Department of Interior
Bureau of Land Management
Washington, DC 20240

Department of Interior
United States Fish & Wildlife Service
C St. Between 18 & 19th, NW
Washington, DC 20240

Portland Regional Office
500 NE Multnomah St.
Suite 1692
Portland, OR 97232

Albuquerque Regional Office
500 Gold Ave., SW
Rm. 9018
Albuquerque, NM 87103

Twin Cities Regional Office
Federal Building, Fort Snelling
Twin Cities, MN 55111

Atlanta Regional Office
Richard B. Russell Federal Bldg.
75 Spring St., SW, Rm. 1200
Atlanta, GA 30303

Boston Regional Office
One Gateway Ctr., Suite 700
Newton Corner, MA 02158

Denver Regional Office
134 Union Blvd.
P.O. Box 25486
Denver Federal Ctr.
Denver, CO 80225

Alaska Regional Office
1011 E. Tudor Rd.
Anchorage, AK 99503

National Marine Fisheries Service
US Dept. of Commerce
NOAA
Washington, DC 20235

Soil Conservation Service
P.O. Box 2890
Washington, DC 20013

NATIONAL ORGANIZATIONS

American Bass Association, Inc.
P.O. Box 4158
Montgomery, AL 36103-4158
205-567-6035

American Fisheries Society
5410 Grosvenor Ln.
Bethesda, MD 20814
301-897-8616

American Fishing Tackle Manufacturers Association
1250 Grove Avenue
Barrington, IL 60010
312-381-9490

Bass Anglers Sportsman Society
1 Bell Rd.
Montgomery, AL 36117
205-272-9530

Bass Research Foundation
P.O. Box 99
Starkville, MS 39759
601-323-3131

BOAT/U.S. Foundation for Boating Safety
880 South Pickett St.
Alexandria, VA 22304
800-336-BOAT

Future Fisherman Foundation
One Berkley Drive
Spirit Lake, IA 51360
800-237-5539

International Association of Fish and Wildlife Agencies
444 North Capitol St., N.W.
Washington, DC 20001
202-624-7890

International Game Fish Association
3000 E. Las Olas Blvd.
Ft. Lauderdale, FL 33316-1616
305-467-0161

Izaak Walton League of America, Inc.
1701 N. Fort Myer Dr.
Suite 1100
Arlington, VA 22209
703-528-1818

Marine Retailers Association of America
155 N. Michigan, Suite 523
Chicago, IL 60601
312-938-0359

National Marine Manufacturers Association
2550 M. Street, NW
Washington, DC 20037

National Wildlife Federation
1412 Sixteenth St., NW
Washington, DC 20036-2266
202-637-3722

Sport Fishing Institute
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1010 Massachusetts Ave., NW
Washington, DC 20001
202-898-0771

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Vienna, VA 22180

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Sea Grant Program
Miss.-Ala. Sea Grant Consortium
Caylor Bldg.
Gulf Coast Research Lab
Ocean Springs MS 39564
(601) 875-9341

State Extension Services
Director, Cooperative Extension Service
Auburn University
Auburn 36849
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Alabama Wildlife Federation
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Montgomery 36104
(205) 832-9453

Alaska

Department of Fish and Game
P.O. Box 3-2000
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(907) 465-4100

Department of Natural Resources
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Phoenix 85023
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(602) 621-7209

Arizona Wildlife Federation
4330 W. 62nd St. #102
Scottsdale 85251
(602) 946-6160

Arkansas

Game and Fish Commission
#2 Natural Resources Dr.
Little Rock 72205
(501) 223-6300

State Extension Services
Extension Fisheries Specialist
P.O. Box 391
Little Rock 72203
(501) 373-2637

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7509 Cantrell Rd. #226
Little Rock 72207
(501) 663-7255

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The Resources Agency
Department of Fish and Game
1416 Ninth St., Rm. 1311
Sacramento 95814
(916) 445-5656

Sea Grant College Program
University of California
San Diego
La Jolla 92093
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State Extension Services
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Fort Collins 80523
(303) 491-6281

Colorado Wildlife Federation
1560 Broadway Ste. 895
Denver 80202
(303) 830-2557

Trout Unlimited Colorado Council
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State Extension Services
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Storrs 06268
(203) 486-2917

Connecticut Wildlife Federation
27 Washington St.
Middletown 06457
(203) 347-1291

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Department of Natural Resources and Environmental Control
89 Kings Highway
P.O. Box 1401
Dover 19903

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University of Delaware
Newark 19716
(302) 451-2841

State Extension Service
University of Delaware
Newark 19717-1303
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Wildlife Federation of Delaware
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Newark 19711

Trout Unlimited Delaware Chapter
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Trout Unlimited National Capital Chapter
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Baltimore MD 21209
(301) 367-2144/628-6042

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Game and Fresh Water Fish Commission
620 S. Meridian St.
Tallahassee 32301
(904) 488-1960

Sea Grant College
Bldg. 803, Rm. 4
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Gainesville 32611
(904) 392-5870

State Cooperative Extension Services
1038 McCarty Hall
University of Florida
Gainesville 32611
(904) 392-1761

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West Palm Beach 33406
(305) 439-3499

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Department of Natural Resources
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Atlanta 30334
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Georgia Wildlife Federation
4019 Woburn Dr.
Tucker 30084
(404) 934-1955

Trout Unlimited Georgia Council
204 Weatherstone Pkwy.
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Department of Land and Natural Resources
Box 621
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Sea Grant Program
University of Hawaii
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Conservation Council for Hawaii
Box 2923
Honolulu 96802

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Fish and Game Department
600 S. Walnut, Box 25
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University of Idaho
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(208) 885–6684

Idaho Wildlife Federation
432 S. 11th St.
Pocatello 83201
(208) 233–3079

Trout Unlimited Idaho (Upper Snake River) Chapter
748 Adell
Idaho Falls 83402

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Department of Conservation
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524 S. Second St.
Springfield 62706
(217) 782–6302

State Extension Services
122 Mumford Hall
1301 W. Gregory Dr.
University of Illinois
Urbana 61801
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Illinois Wildlife Federation
123 S. Chicago St.
Rossville 60963
(217) 748–6365

Trout Unlimited Illinois Council
600 S. Dearborn St. #2202
Chicago 60605
(312) 236–1600

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Indianapolis 46204
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State Extension Services
Purdue University
West Lafayette 47907
(317) 494–8489

Indiana Wildlife Federation
Box 283
Zionsville 46077
(317) 873–3915

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Department of Natural Resources
E. Ninth and Grand Ave., Wallace Bldg.
Des Moines 50319–0034
(515) 281–8666

State Extension Services
Extension Wildlife Conservationist
103 Science II
Iowa State University
Ames 50011
(515) 294–7429

Iowa Wildlife Federation Inc.
Box 1222
Cedar Rapids 52406
(319) 556–0088

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Fish and Game Commission
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Pratt 67124
(316) 672–5911

State Extension Services
Wildlife and Outdoor Recreation
Community Development Programs
215 Umberger Hall
Kansas State University
Manhattan 66506
(913) 532–5840

Kansas Wildlife Federation Inc.
200 S.W. 30th St., Suite 101
Topeka 66611
(913) 266–6185

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Department of Fish and Wildlife Resources
#1 Game Farm Rd.
Frankfort 40601
(502) 564-3400

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Lexington 40546
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League of Kentucky Sportsmen, Inc.
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Lexington 40524
(606) 865-4407

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Department of Wildlife and Fisheries
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(504) 925-3617

Sea Grant College Program
Center for Wetland Resources
Louisiana State University
Baton Rouge 70803
(504) 388-6710

State Extension Services
Specialist, Wildlife and Sea Grant
Louisiana State University
Baton Rouge 70803
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Louisiana Wildlife Federation, Inc.
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Louisiana State University
Baton Rouge 70893
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Department of Inland Fisheries and Wildlife
284 State St.
Station #41
Augusta 04333
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Department of Marine Resources
State House
Station #21
Augusta 04333
(207) 289-2291

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Natural Resources/Community Development
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Orono 04469
(207) 581-3194

Natural Resources Council of Maine
271 State St.
Augusta 04330
(207) 622-3101

Trout Unlimited Maine Council
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Belgrade Lakes 04918
(207) 495-2056

Maryland

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Annapolis 21401
(301) 269-3041

Sea Grant College
University of Maryland
College Park 20742
(301) 454-5690

State Extension Services
University of Maryland
College Park 20742
(301) 454-3742

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3720 Farragut Ave.
Kensington 20795

Massachusetts

Department of Fisheries, Wildlife, & Environmental Law
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Boston 02202
(616) 727-1614

State Extension Services
University of Massachusetts
Amherst 01003
(413) 545-4800

Massachusetts Wildlife Federation
295 E. Riding Dr.
Carlisle 01741
(617) 369-3118

Trout Unlimited Massachusetts/Rhode Island Council
473 Main St.
Greenfield 01301
(413) 773-5920

Michigan

Department of Natural Resources
Box 30028
Lansing 48909
(517) 373-1220

State Extension Services
Michigan State University
East Lansing 48824
(517) 355-2803

Michigan United Conservation Clubs, Inc.
2101 Wood St., Box 30235
Lansing 48909
(517) 371-1041

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16803 Westmoreland
Detroit 48219
(313) 531-2532

Minnesota

Department of Natural Resources
500 Lafayette Rd.
St. Paul 55146
(612) 296-6157
Toll Free (800) 652-9747

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University of Minnesota
240 Coffey Hall
St. Paul 55108
(612) 624-2703

Minnesota Conservation Federation
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St. Paul 55116
(612) 690-3077

Trout Unlimited Minnesota Council
318 E. 3rd St.
Albert Lea 56007
(507) 373-5863

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Southport Mall
P.O. Box 451
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(601) 961-5300

Sea Grant Program
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(601) 875-9341

State Extension Services
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Delta Branch Experiment Station
Stoneville 38776
(601) 686-9311 ext. 302

Mississippi Wildlife Federation
520 N. President St.
Jackson 39201
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Department of Conservation
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Jefferson City 65102
(314) 751-4115

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309 University Hall
Columbia 65211
(314) 882-7754

Conservation Federation of Missouri
728 W. Main St.
Jefferson City 65101-1543
(314) 634-2322

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Department of Fish, Wildlife and Parks
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Helena 59620
(406) 444-2535

State Extension Services
Montana State University
Bozeman 59717
(406) 994-3402

Montana Wildlife Federation
P.O. Box 3526
Bozeman 59715
(406) 587-1713

Trout Unlimited Montana Council
344 Clancy St.
Helena 59601
(406) 442-1973

Nebraska

Games and Parks Commission
2200 N. 33rd St., P.O. Box 30370
Lincoln 68503
(402) 464-0641

Extension Wildlife Specialist
Department of Forestry
Fisheries and Wildlife
University of Nebraska
202 Natural Resources Hall
Lincoln 68583-0819
(402) 472-1467

Nebraska Wildlife Federation Inc.
c/o Bozell & Jacobs
10250 Regency Cir.
Omaha 68114
(402) 399-5894

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Box 10678
Reno 89520
(702) 789-0500

State Extension Service
University of Nevada
Reno 89557
(702) 784-1621

Nevada Wildlife Federation
P.O. Box 71238
Reno 89570
(702) 825-5158

New Hampshire

Fish and Game Department
34 Bridge St.
Concord 03301
(603) 271-3421

Sea Grant Program
Communication and Information Director
Marine Program Bldg.
University of New Hampshire
Durham 03824
(603) 862-2996

State Extension Services
University of New Hampshire, Taylor Hall
Durham 03824
(603) 862-1520

New Hampshire Wildlife Federation, Inc.
Box 239
Concord 03301
(603) 224-2984

New Jersey

Department of Environmental Protection
Division of Fish, Game, and Wildlife
CN 400
Trenton 08625
(609) 292-2965

Sea Grant Program
NJSGES, P.O. Box 231
Rutgers University/Cook College
New Brunswick 08903
932-9636

State Extension Services
Rutgers—The State University
New Brunswick 08903
932-9306

New Jersey State Federation of Sportsmen's Clubs
Box 267
Cologne 08213-0267

Trout Unlimited New Jersey Council
8 Suttie Ave.
Piscataway 08854
(201) 463-0634

New Mexico

Natural Resources Department
Game and Fish Department
Villagra Bldg.
Santa Fe 87503
(505) 827-7899

State Extension Services
Extension Wildlife Management Specialist
Box 4901, New Mexico State University
Las Cruces 88003
(505) 646-3748 ext. 1164

New Mexico Wildlife Federation
300 Val Verde SE
Albuquerque 87108
(505) 265-7372

Trout Unlimited New Mexico
8709 Aztec NE
Albuquerque 87111
(505) 299-0410

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Department of Environmental Conservation
Division of Fish and Wildlife
50 Wolf Rd.
Albany 12233
(518) 457-5691

Sea Grant Program
State University of New York and Cornell University
37 Elk St.
Albany 12246
(518) 436-0701

New York State Conservation Council, Inc.
8 E. Main St.
Ilion 13357-1899
(315) 894-3302

Trout Unlimited New York Council
7 Dorothy St.
Bethpage 11714
(516) 935-3798

North Carolina

Department of Natural Resources
and Community Development
P.O. Box 27687
Raleigh 27611
(919) 733-4984

Sea Grant Program
Box 8605, North Carolina State University
Raleigh 27695-8605
(919) 737-2454

State Extension Services
Extension Fisheries Specialist
Box 7617, North Carolina State University
Raleigh 27695
(919) 737-2741

North Carolina Wildlife Federation
Box 10626
Raleigh 27605
(919) 833-1923

Trout Unlimited, North Carolina Council
Rt. 1, Box 20-A
Sparta 28675

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Extension Wildlife Specialist
Stevens Hall, North Dakota State University
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(701) 237-7950

State Game and Fish Department
100 North Bismarck Expressway
Bismarck 58501
(701) 221-6300

North Dakota Wildlife Federation, Inc.
P.O. Box 7248
Bismarck 58502
(701) 222-2557

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Sea Grant Program and Center for Lake Erie Area Research
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484 W. 12th St.
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Ohio State Univesity, 2021 Coffey Rd.
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League of Ohio Sportsmen
3953 Indianola Ave.
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Oklahoma

Department of Wildlife Conservation
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Oklahoma City 73152
(405) 521-3851

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Oklahoma City 73105
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(503) 229-5551

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Corvallis 97331
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Oregon Wildlife Federation
2753 N. 32nd
Springfield 97477
(503) 747-8400

Trout Unlimited Oregon
2627 Hastings St.
Eugene 97404
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Pennsylvania

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P.O. Box 1673
Harrisburg 17105
(717) 657-4518

State Extension Services
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109 Ferguson Bldg., Pennsylvania State University
University Park 16802
863-0401

Pennsylvania Federation of Sportsmen's Clubs, Inc.
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(717) 232-3480

Trout Unlimited Pennsylvania Council
Rd #2, Box 291
Punxsutawney 15767
(717) 599-5414

Puerto Rico

Extension Services
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Mayaguez 00780
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GPO Box 1036
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Rhode Island

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Providence 02903
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University of Rhode Island
Kingston 02881
(401) 792-2474

Environment Council of Rhode Island, Inc.
40 Bowen St.
Providence 02903
(401) 521-1670

Trout Unlimited Rhode Island Chapter
1225 Charles St.
Upper Providence 02904
(401) 723-8765

South Carolina

Division of Energy and Environment
P.O. Box 11450
Office of the Governor
Columbia 29201
(803) 734-0445

Sea Grant Consortium
287 Meeting St.
Charleston 29401
(803) 727-2078

State Extension Services
Extension Fish and Wildlife Specialist
307 Long Hall, Clemson University
Clemson 29634-0362
656-3117

South Carolina Wildlife Federation
Box 4186, 4949 Two Notch Rd., #B-1
Columbia 29240
(803) 786-6419

Trout Unlimited South Carolina Council
112 Kip Ct.
Irmo 29063

South Dakota

Game, Fish & Parks Department
445 East Capitol
Pierre 57501-3185
(605) 773-3387

State Extension Services
South Dakota State University
Brookings 57007
(605) 688-4147

South Dakota Wildlife Federation
812 N. Monroe
Pierre 57501
(605) 224-5360

Tennessee

Department of Conservation
701 Broadway—Customs House
Nashville 37203
(615) 742-6749

State Extension Services
Dept. of Forestry, Wildlife and Fisheries
P.O. Box 1071
University of Tennessee
Knoxville 37901-1071
(615) 974-7126

Wildlife Resources Agency
P.O. Box 40747
Ellington Agricultural Center
Nashville 37204
(615) 360-0500

Tennessee Conservation League
1720 West End Ave., Suite 300
Nashville 37203
(615) 329-4230

Trout Unlimited Tennessee Council
1032 Jackson's Valley Rd.
Hermitage 37076

Texas

Agricultural Extension Service
Extension Fisheries Specialist
Texas A&M University
College Station 77843
(409) 845-7471

Parks and Wildlife Department
4200 Smith School Rd.
Austin 78744
(512) 479-4800

Sea Grant Program
Marine Information Service
Texas A&M University
College Station 77843
(409) 845-7524

Sportsmen's Clubs of Texas, Inc.
311 Vaughn Bldg. #807 Brazos St.
Austin 78701
(512) 472-2267

Trout Unlimited Texas Chapter
326 Fenwick
San Antonio 78239
(512) 653-7326

Utah

State Department of Natural Resources
1636 West North Temple
Salt Lake City 8411-3156
(801) 533-5356

State Extension Services
Utah State University
Logan 84322
(801) 750-2461

Utah Wildlife Federation
P.O. Box 15636
Salt Lake City 84115

Trout Unlimited Utah
703 West Daisy Ln.
Murray 84102
(801) 566-0796

Vermont

Agency of Environmental Conservation
Department of Fish and Wildlife
Waterbury Complex, 10 South
Montpelier 05602
(802) 244-7331

State Extension Services
Water Resource Specialist
Aiken Center-Natural Resources
University of Vermont
Burlington 05405
(802) 656-4057

Vermont Natural Resources Council
7 Main St.
Montpelier 05602
(802) 223-2328

Trout Unlimited Vermont Council
P.O. Box 910
White River Junction 05001
(802) 295-5925

Virgin Islands

Department of Conservation and Cultural Affairs
P.O. Box 4399
St. Thomas 00801
(809) 774-3320

Virgin Islands Conservation Society, Inc.
Box 12379
St. Thomas 00801

Virginia

Commission of Game and Inland Fisheries
4010 W. Broad St., Box 11104
Richmond 23230
(804) 257-1000

Sea Grant Program
Virginia Graduate Marine Science Consortium
203 Monroe Hill House, University of Virginia
Charlottesville 22903
(804) 924-5965

State Extension Services
Extension Fisheries Specialist
Virginia Polytechnic Institute & State University
Blacksburg 24061
(703) 961-5059

Virginia Wildlife Federation
4602 D West Grove Ct.
Virginia Beach 23455
(804) 464-3136

Trout Unlimited Virginia Council
7210 Jill Spring Ct.
Springfield 22152

Washington

Department of Fisheries
115 General Administration Bldg.
Olympia 98504
(206) 753-6600

State Extension Services
Washington State University
Pullman 99164-6230
(509) 335-2811

Washington State Sportsmen's Council
P.O. Box 357
Clear Lake 98235
(206) 856-4774

Trout Unlimited Northwest Steelhead and Salmon Council
P.O. Box 2137
Olympia 98507

West Virginia

Department of Natural Resources
1800 Washington St., East
Charleston 25305
(304) 348-2754

State Extension Services
University Extension Public Service
West Virginia University, 817 Knapp Hall
Morgantown 26506
(304) 293-5691

West Virginia Wildlife Federation, Inc.
Box 275
Paden City 26159
(304) 337-9166/427-2171

Wisconsin

Department of Natural Resources
Bureau of Fish Management
Box 7921
Madison 53707
(608) 266-7025

State Extension Services
University of Wisconsin
432 North Lake St.
Madison 53706
(608) 263-2775

Wisconsin Wildlife Federation
Tranquil Acres
Reeseville 53579
(414) 927-3131

Trout Unlimited Wisconsin Council
1282 Monterey St.
De Pere 54115
(414) 336-4983

Wyoming

Game and Fish Department
Cheyenne 82002
(307) 777-7631

State Extension Services
University Station, Box 3354
Laramie 82071
(307) 766-5124

Wyoming Wildlife Federation
P.O. Box 106
Cheyenne 82003
(307) 637-5433

Trout Unlimited Wyoming
4615 Gusel Pl.
Cheyenne 82009

APPENDIX

B

Sources of Fishing Tackle, Equipment, and Free and/or Inexpensive Materials

The companies mentioned below have products that instructors may find useful while teaching from the Aquatic Resources Education Curriculum. Only instructors or others responsible for the Curriculum should contact these companies inquiring about the availability of tackle, equipment, or instructional or informational materials. Inquiries regarding the availability of items for use with the Curriculum should be written on letterhead stationery and should mention that the Aquatic Resources Education Curriculum is being utilized.

The types of items that may be available are listed below and numbered. The numbers following each company listing indicate the product or items that each may have available for use.

1. Accessories
2. Audio Tapes
3. Bait
4. Boating Safety Course
5. Books
6. Downrigger Accessories
7. Downriggers
8. Electric Trolling Motors
9. Electronic Equipment
10. Fish Attractant
11. Fly Fishing—Flies
12. Fly Fishing—Rods and Reels
13. Fly Fishing—Fly Tying Materials
14. Hooks
15. Ice Fishing
16. Instructional Brochures or Books
17. Knives
18. Line
19. Lures
20. Personal Flotation Devices PFD's
21. Product Catalogs
22. Reels
23. Rods
24. Tackle Boxes
25. Terminal Tackle
26. Video Tapes
27. Wall Charts

ABU-Garcia, Inc.
28 Law Drive
Fairfield, N.J. 07006
(1, 18, 21, 22, 23)

All Sports Book Distributors
790 W. Tennessee Ave.
Denver, CO 80223
(26)

Arbogast
313 West North Street
Akron, OH 44303
(12, 13, 19, 21)

Babe Winkleman Productions
P.O. Box 407
Brainerd, MN 56401
(2, 5, 26)

Berkley, Inc.
One Berkley Drive
Spirit Lake, IA 51360
(1, 10, 12, 16, 21, 23, 24)

Big John, Inc.
14393 Peninsula Drive
Traverse City, MI 49684
(6–7)

Blakemore Lure Company, Inc.
P.O. Box 1149
Hwy 65 North
Branson, MO 65616
(1, 19, 21)

BOAT/U.S. Foundation for Boating Safety
880 S. Pickett St.
Alexandria, VA 22304
800-336-BOAT
(4)

Boone Company
P.O. Box 4009
Winter Park, FL 32793
(1, 19, 21)

Buck Knives
P.O. Box 1267
El Cajon, CA 92022
(1, 16, 17, 21)

Burke Fishing Lures
McClellan Industries
P.O. Box 72
Traverse City, MI 49685
(1, 19, 21)

Chicago Cutlery
5420 N. County Rd. 18
Minneapolis, MN 55428
(1, 16, 17, 21)

Cannon/S & K Products, Inc.
1732 Glade Street
Muskegon, MI 49441
(6, 7, 16, 21)

Cordell Tackle
3601 Jenny Lind Road
Fort Smith, AR 72901
C/O Public Relations Dept.
(1, 19, 21)

Cy DeCosse Incorporated
The Hunting & Fishing Library
5900 Green Oak Drive
Minnetonka, MN 55343
(5)

Daiwa Corporation
7421 Chapman Avenue
Garden Grove, CA 92641
(1, 21, 22, 23)

E. I. DuPont Company
Fishing Products Group
1007 Market St.
B-6236
Wilmington, De 19898
(16, 18, 21)

Eppinger Manufacturing
6340 Schaefer
Dearborn, MI 48126
(19, 21)

Fenwick/Wookstream
Front & Locust Streets
Lititz, PA 17543
(1, 9, 21, 24)

Fenwick/Woodstream
14799 Chestnut Street
Westminster, CA 92683
(12, 21, 23)

FIM Publishing
"Pocket Guide To Fishing"
P.O. Box 201
Phoenix, MD 21131
(16)

Future Fisherman Foundation
One Berkley Drive
Spirit Lake, Iowa 51360
(16, 26)

Humminbird
1 Humminbird Lane
Eufaula, AL 36027
C/O Telmarketing Dept.
(1, 9, 21)

In Fisherman
P.O. Box 999
Brainerd, MN 56401
(5, 26)

James Heddon's Sons, Inc.
3601 Jenny Lind Road
Fort Smith, AR 72901
C/O Public Relations Dept.
(19, 21)

Johnson Fishing
1531 Madison Ave.
Mankato, MN 56001
(3, 8, 10, 19, 21, 22, 23)

Lakes Illustrated
Lakes Systems Division
315 South Street
Mt. Vernon, MO 65712
(9, 21)

Lew Childre & Sons, Inc.
110 East Azalea Avenue
Foley, AL 36535
(1, 21, 22, 23)

L. L. Bean
Freeport, Maine 04033
(21, 26)

Lowrance Electronics
12000 East Skelly Drive
Tulsa, OK 74128
(1, 9, 16, 21)

Luhr Jensen & Sons, Inc.
P.O. Box 297
Hood River, OR 97031
(16, 19, 21)

Mann's Bait Company
State Docks Road
Eufaula, AL 36027
C/O Sales Dept.
(10, 16, 19, 21)

Mepps (Sheldons' Inc.)
626 Center St.
Antigo, Wisconsin 54409–2496
(16, 19, 21)

Mister Twister, Inc.
P.O. Drawer 996
Minden, LA 71058
(1, 14, 19, 21)

Penn Fishing Tackle Mfg. Co.
3028 West Hunting Park Avenue
Philadelphia, PA 19132
(7, 21, 22, 23)

Plano Molding Company
P.O. Box 189
Plano, Illinois 60545
(21, 24)

Rebel/Plastics Research & Dev. Corp.
3601 Jenny Lind Road
Fort Smith, AR 72901
C/O Public Relations Dept.
(19, 21, 24)

Scientific Anglers/3M
3M Center, 223–3S
St. Paul, MN 55144
(1, 12, 16, 18, 21, 26)

Shakespeare Company
Fishing Tackle Division
P.O. Drawer S
Columbia, S.C. 29260
(8, 18, 20, 22, 23)

Shimano American Corporation
Fishing Tackle Division
One Shimano Drive
Irvine, CA 92718
(21, 22, 23)

Sport Fishing Institute
1010 Massachusetts Avenue, N.W.
Suite 100
Washington, D.C. 20001
(27)

Stearns PFD's
P.O. Box 1498
St. Cloud, MN 56301
(16, 20, 21)

Tru-Turn
Education Dept.
P.O. Drawer 767
Wetumpka, AL 36092
(14, 16)

Uncle Josh Bait Company
P.O. Box 130
Fort Atkinson, WI 53538
(3, 16, 19)

Walker Downriggers
Pacific Atlantic Products
395 South Pitcher Street
Kalamazoo, MI 49007
(1, 6, 7, 21)

Wright & McGill Co.
P.O. Box 16011
Denver, CO 80216,0011
(14, 16, 21, 22, 23)

Zebco/Motorguide
P.O. Box 270
Tulsa, OK 74101
(8, 16, 21, 22, 23, 26, 27)

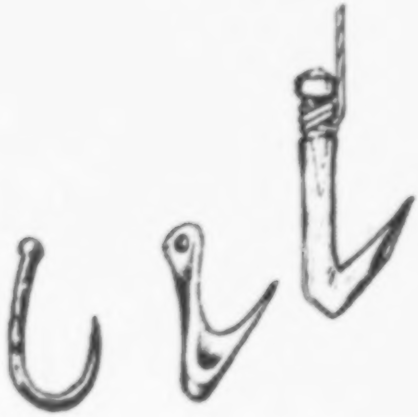
APPENDIX

C

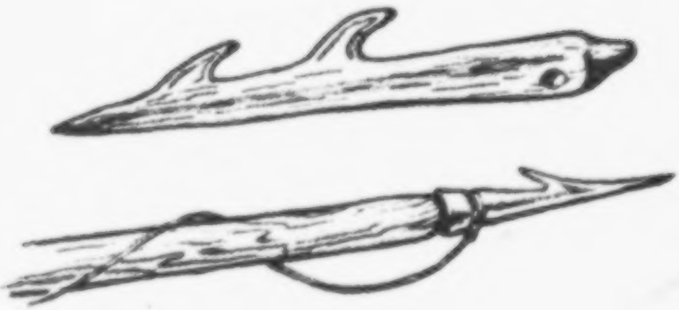
Graphics to Supplement the Lessons

Primitive Fishing Tackle

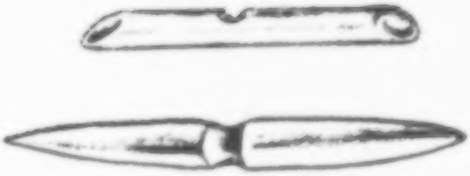
Fish Hooks



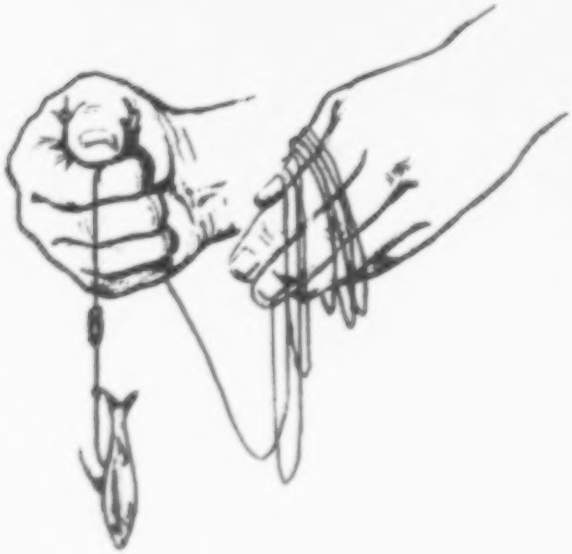
Harpoons



Gorges

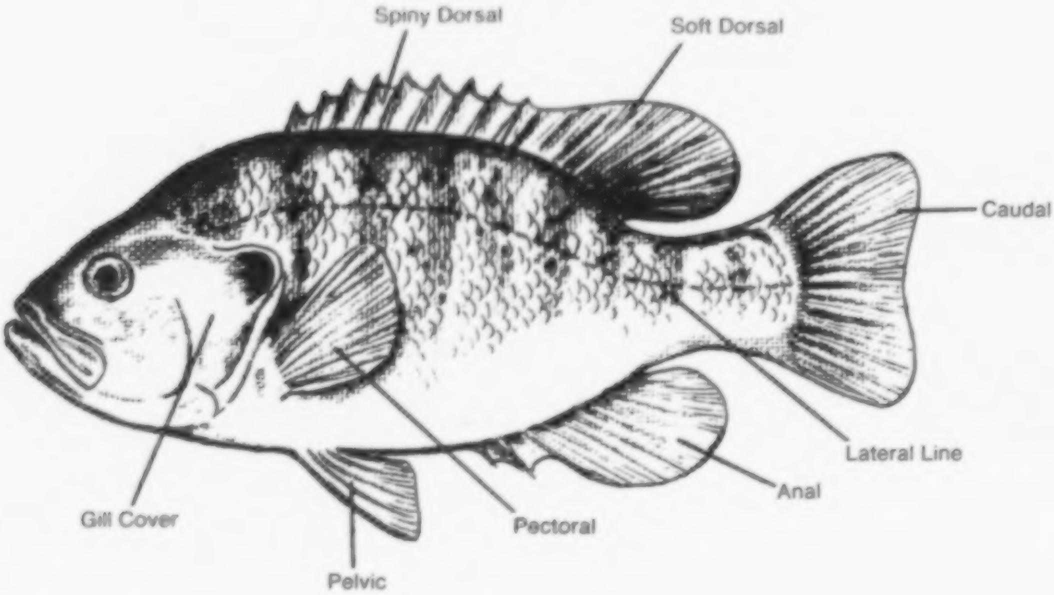


Hand Line—Still Used Today

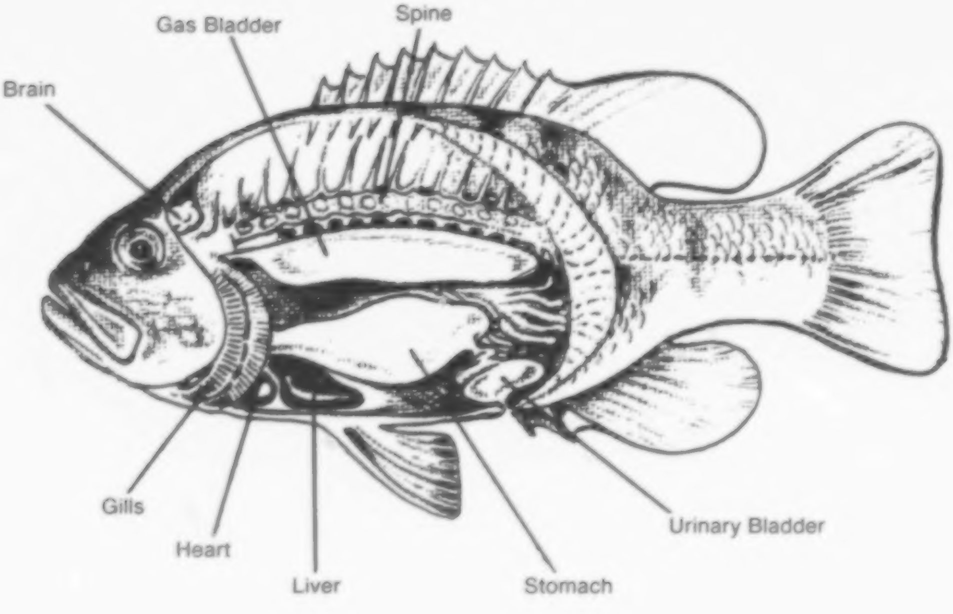


Parts of a Fish

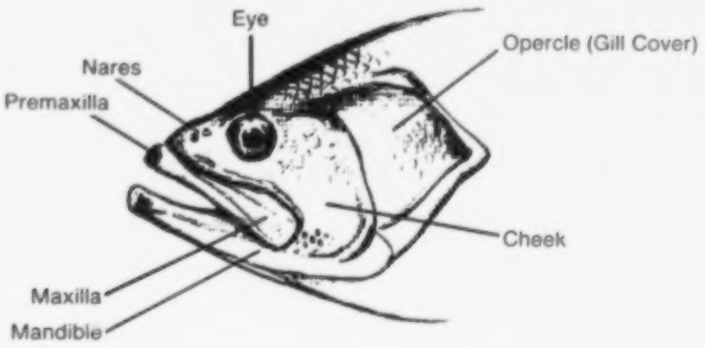
External


Spiny Dorsal
Soft Dorsal
Caudal
Lateral Line
Anal
Gill Cover
Pectoral
Pelvic

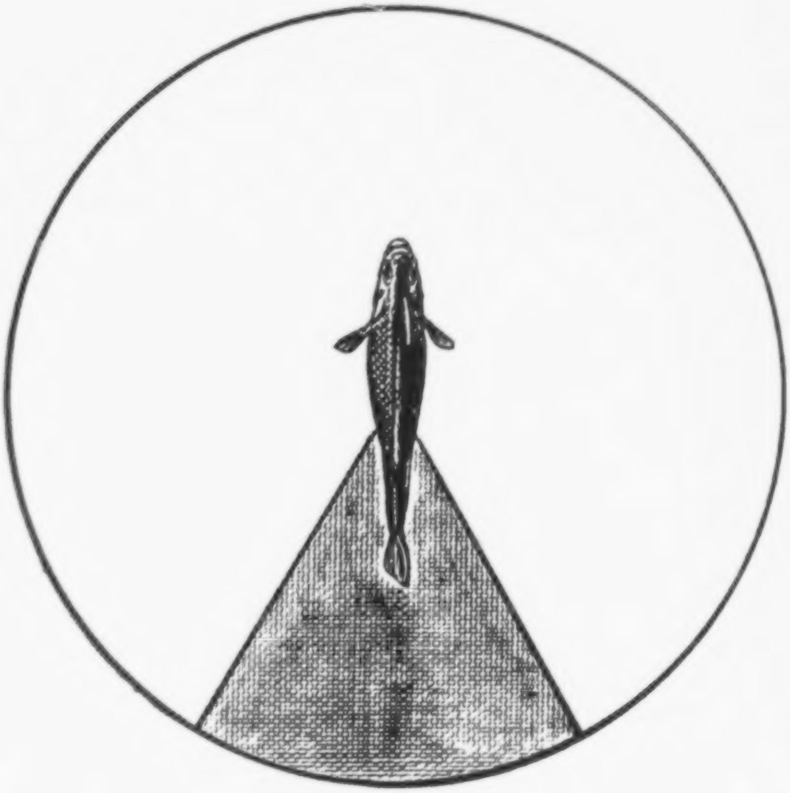
Internal


Gas Bladder
Spine
Brain
Gills
Heart
Liver
Stomach
Urinary Bladder

Parts of a Fish

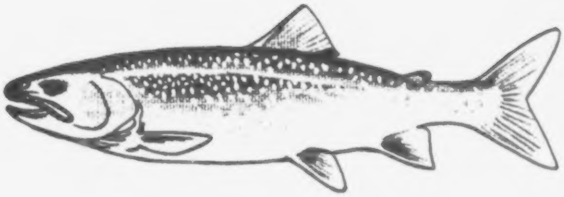

Eye
Nares
Premaxilla
Opercle (Gill Cover)
Cheek
Maxilla
Mandible

Fish Vision

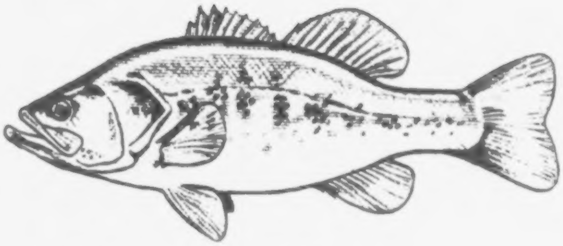

60° Blind

Fish have a broad 300° field of vision. Their "blind spot" is the 60° behind them. For this reason and the fact that most fish will face upstream in a current, most fishermen fish streams by wading upstream. This reduces the opportunity for fish to see the angler.

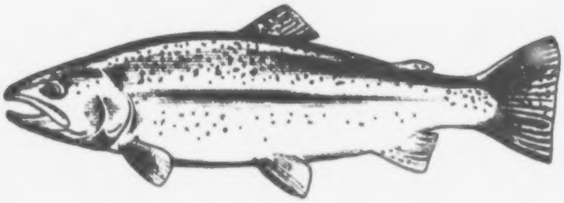
Freshwater Fish



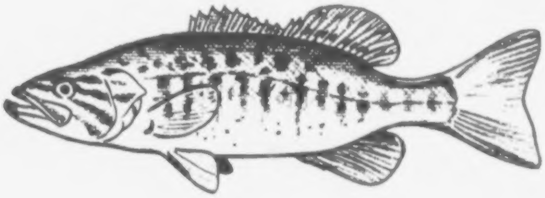
Lake Trout



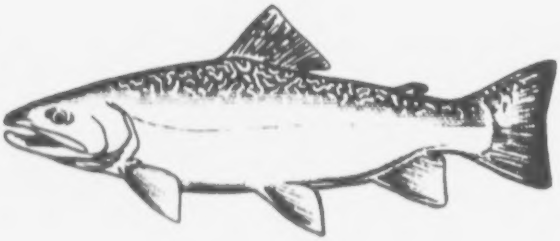
Largemouth Bass



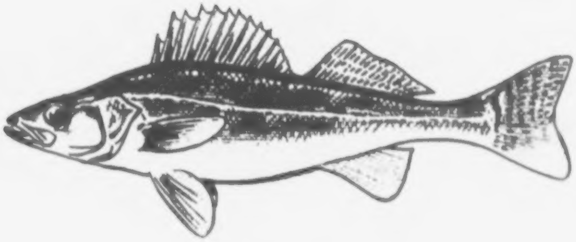
Rainbow Trout



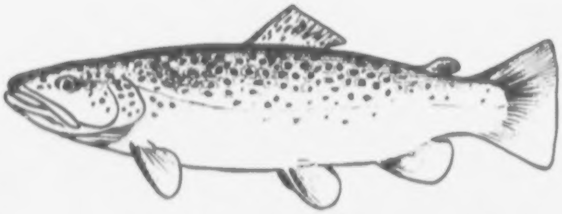
Smallmouth Bass



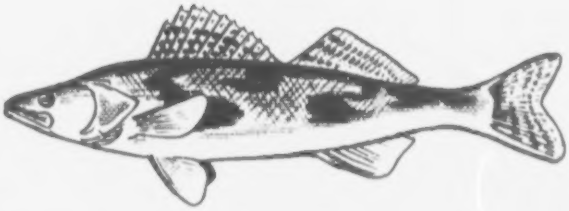
Brook Trout



Walleye

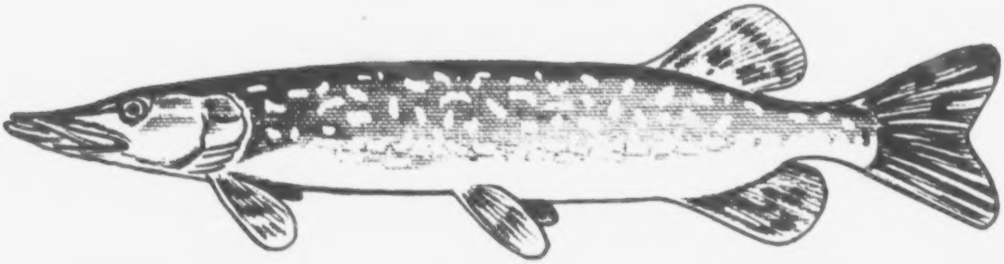


Brown Trout

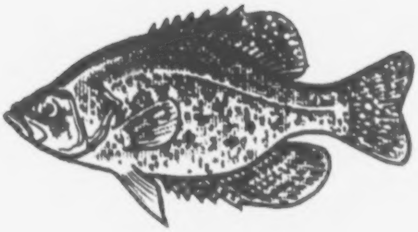


Sauger

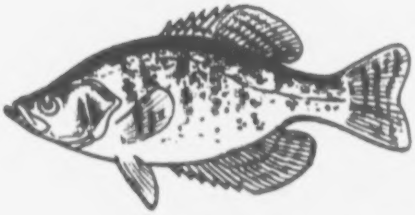
Freshwater Fish



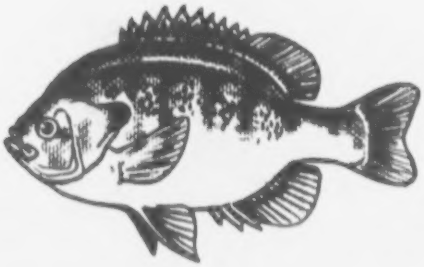
Northern Pike



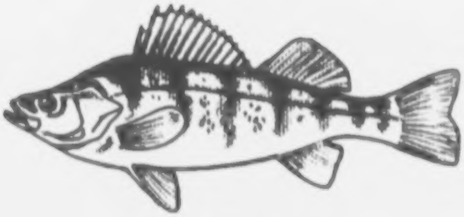
Black Crappie



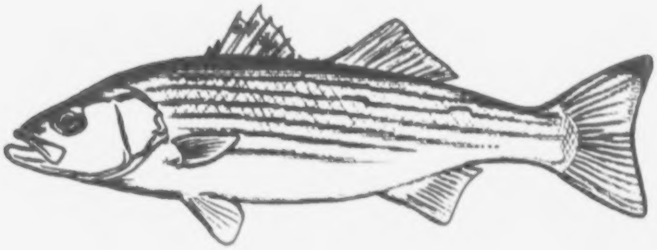
White Crappie



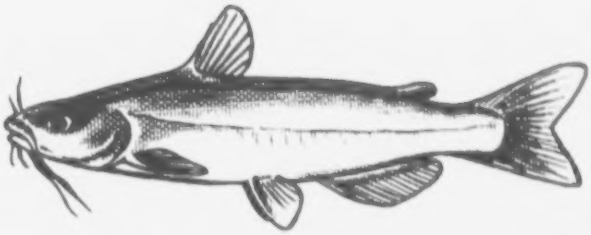
Bluegill



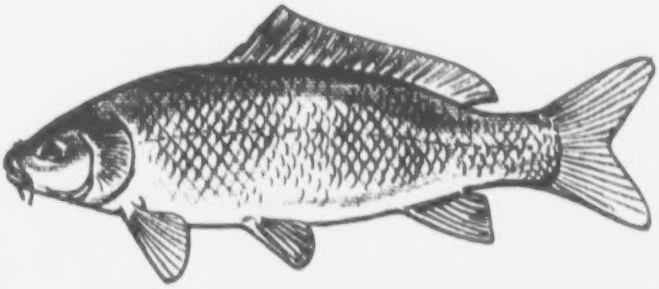
Yellow Perch



Striped Bass



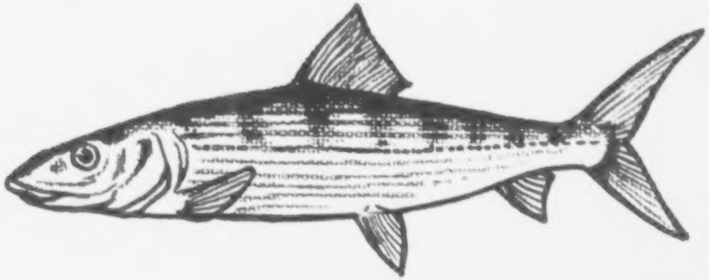
Channel Catfish



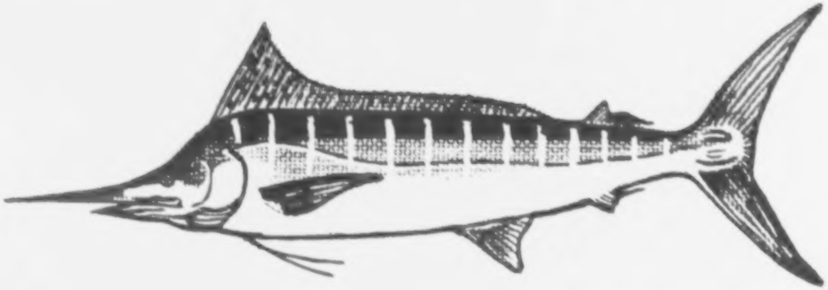
Carp

Saltwater Fish

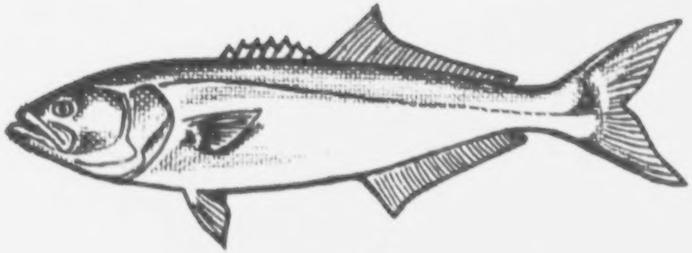
APC.6



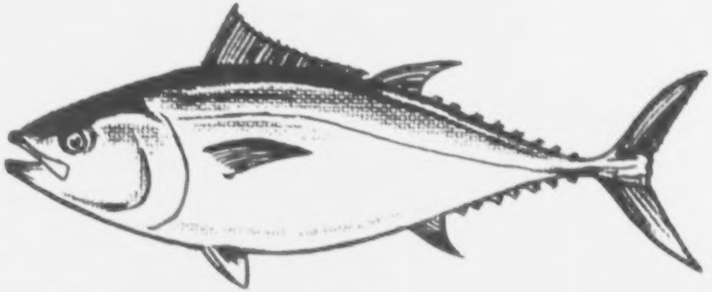
Bonefish



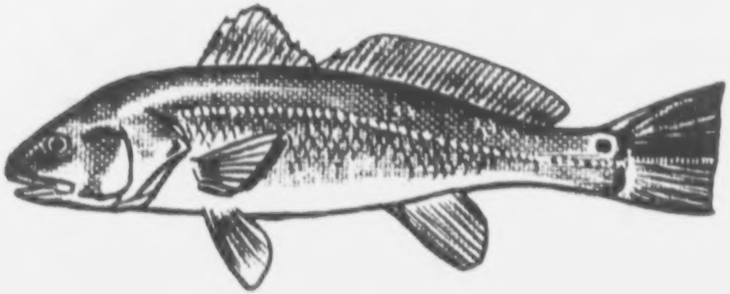
Marlin



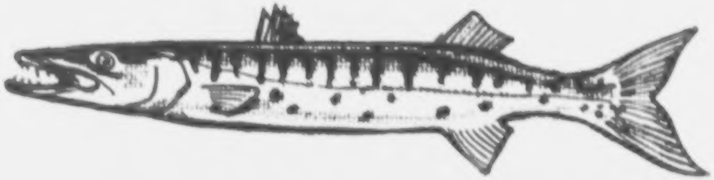
Bluefish



Tuna



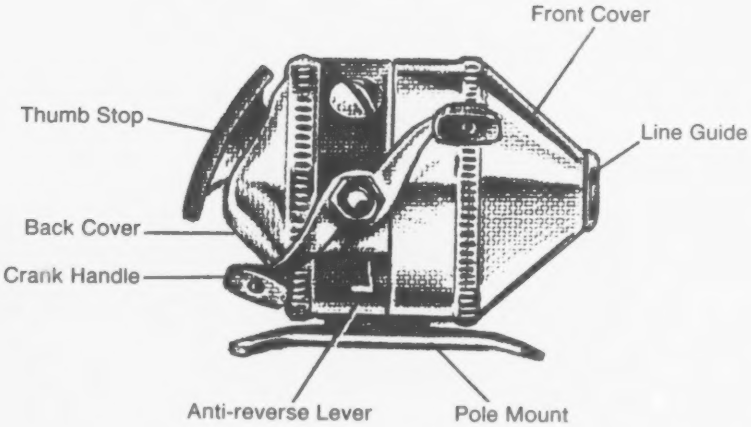
Red Drum or Channel Bass



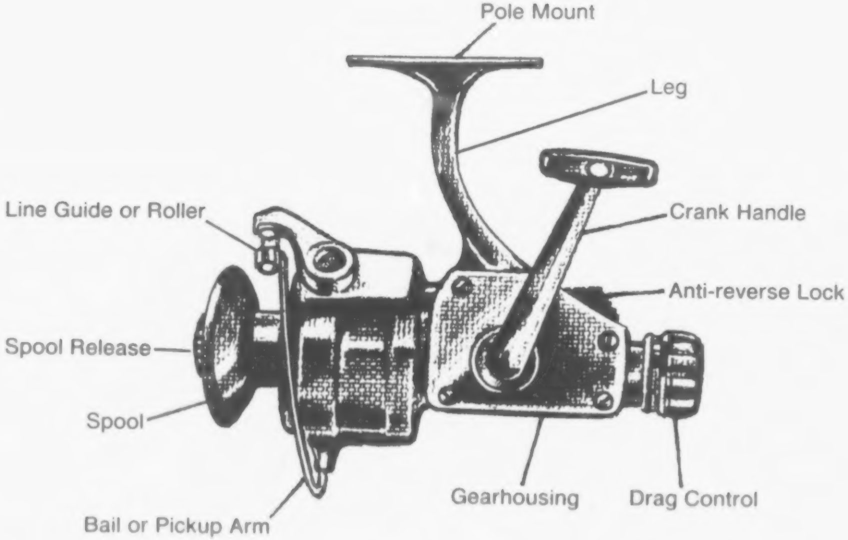
Barracuda

Parts of a Reel

Spincast

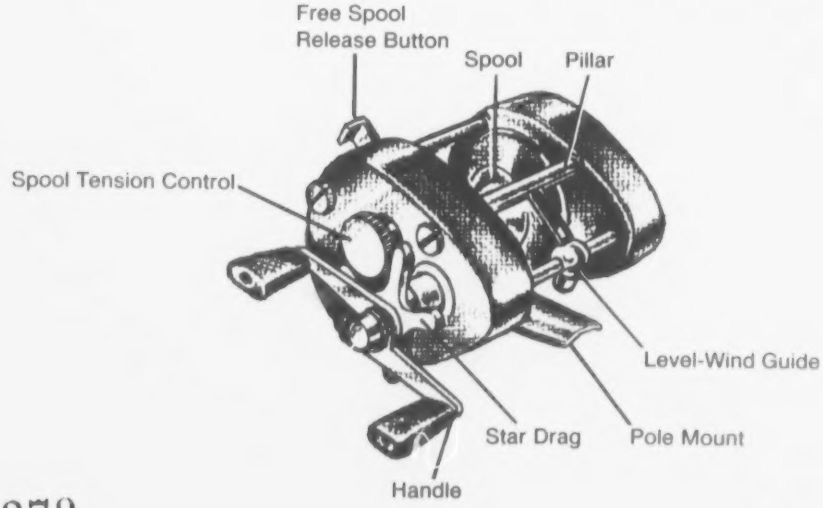

Front Cover
Thumb Stop
Line Guide
Back Cover
Crank Handle
Anti-reverse Lever
Pole Mount

Spinning

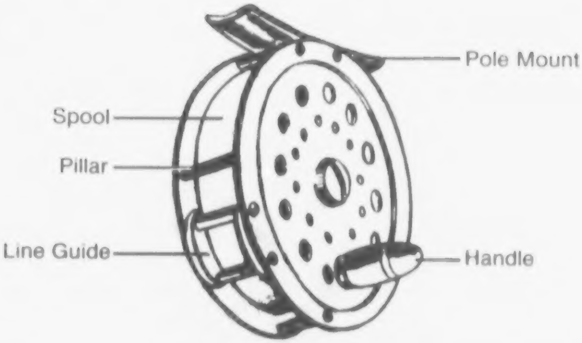

Pole Mount
Leg
Line Guide or Roller
Crank Handle
Anti-reverse Lock
Spool Release
Spool
Gearhousing
Drag Control
Bail or Pickup Arm

APC.7

Bait Casting

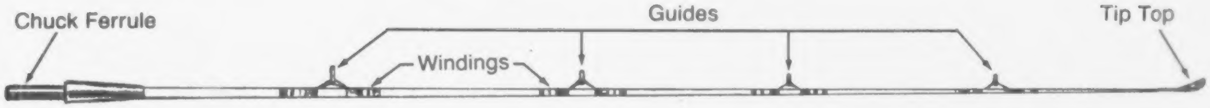

Free Spool
Release Button
Spool
Pillar
Spool Tension Control
Level-Wind Guide
Star Drag
Pole Mount
Handle

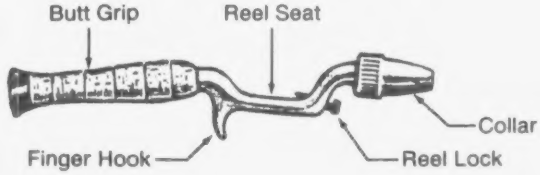
Fly Fishing


Pole Mount
Spool
Pillar
Line Guide
Handle

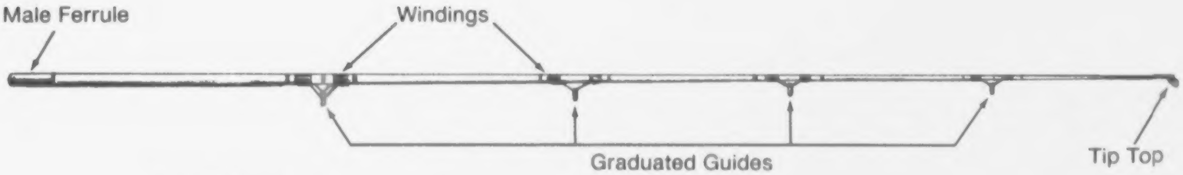
Rods

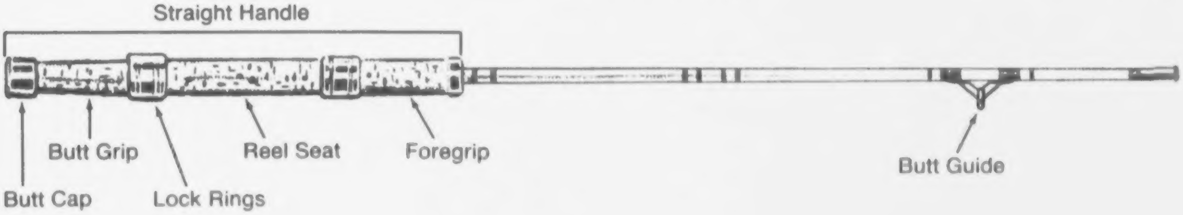
1. Bait or Spin-Casting


Chuck Ferrule
Guides
Tip Top
Windings

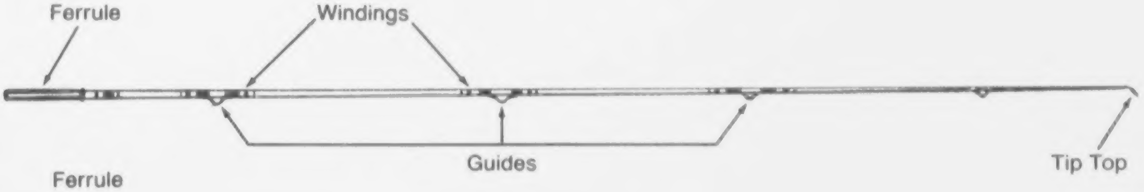

Butt Grip
Reel Seat
Collar
Finger Hook
Reel Lock

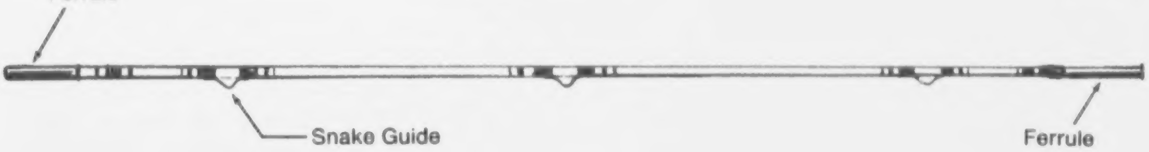
2. Spinning

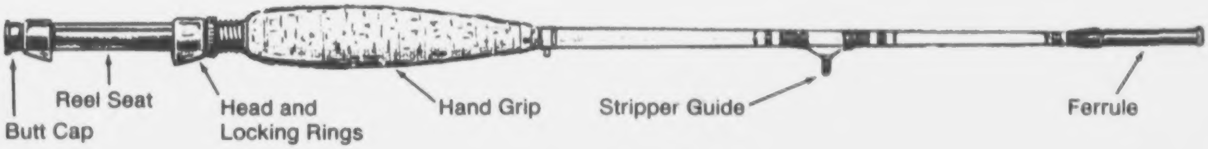

Male Ferrule
Windings
Graduated Guides
Tip Top


Straight Handle
Butt Grip
Reel Seat
Foregrip
Butt Guide
Butt Cap
Lock Rings

3. Fly Rod

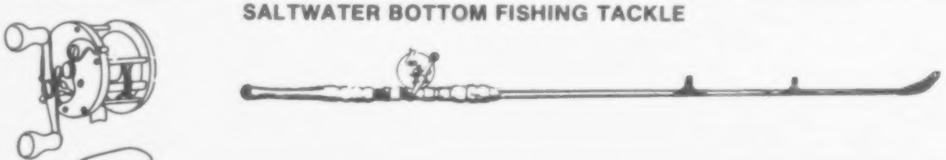

Ferrule
Windings
Guides
Tip Top


Ferrule
Snake Guide
Ferrule


Reel Seat
Butt Cap
Head and Locking Rings
Hand Grip
Stripper Guide
Ferrule

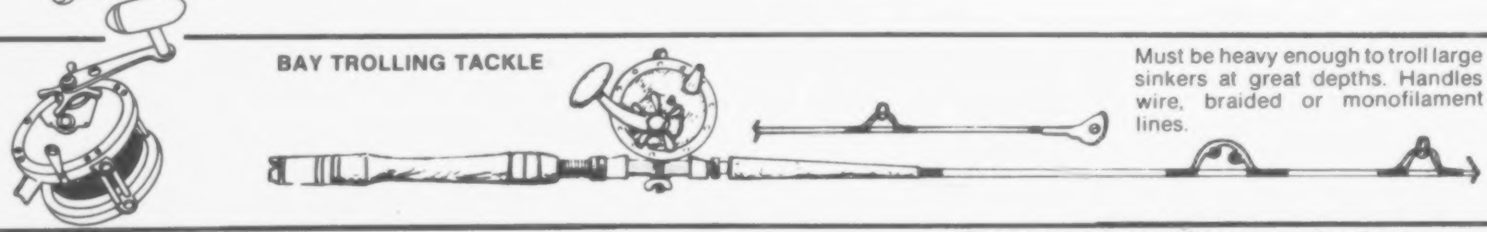
Salt Water Fishing Tackle

SALTWATER BOTTOM FISHING TACKLE



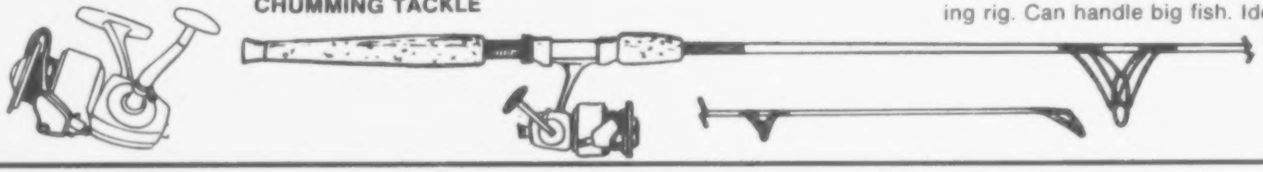
Preferred for bottom fishing in tidal waters. A favorite among bridge fishermen.

BAY TROLLING TACKLE



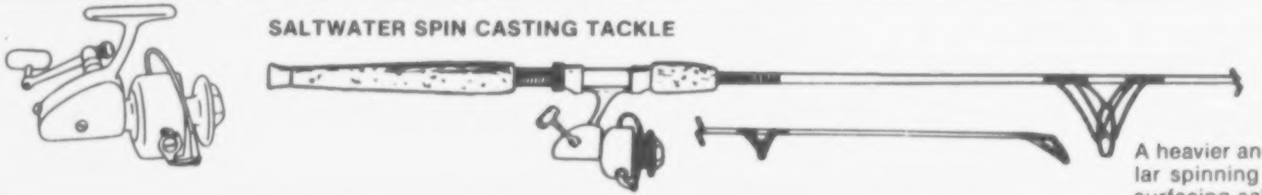
Must be heavy enough to troll large sinkers at great depths. Handles wire, braided or monofilament lines.

CHUMMING TACKLE



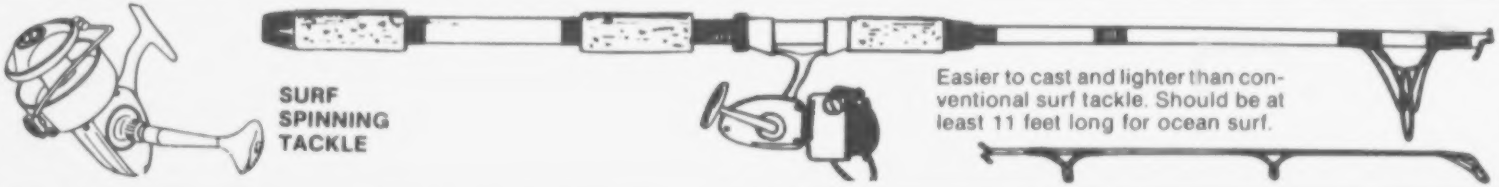
Shorter and stouter than conventional spinning rig. Can handle big fish. Ideal for drifting bait in a chum line.

SALTWATER SPIN CASTING TACKLE



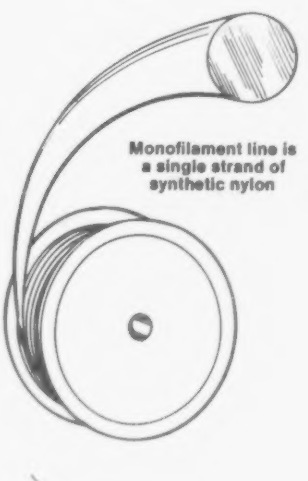
A heavier and longer version of regular spinning rig. Used for casting to surfacing salt water fish.

SURF SPINNING TACKLE

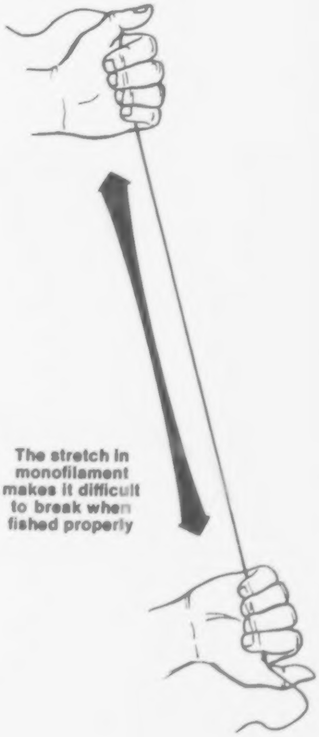


Easier to cast and lighter than conventional surf tackle. Should be at least 11 feet long for ocean surf.

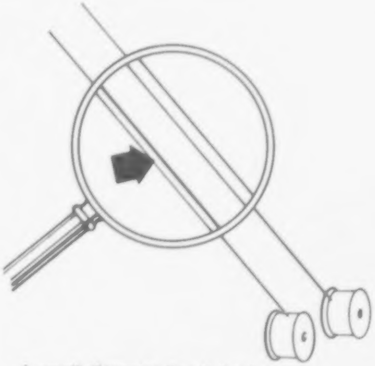
monofilament



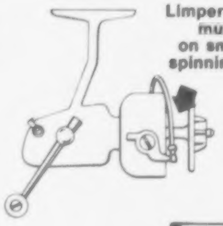
Monofilament line is a single strand of synthetic nylon



The stretch in monofilament makes it difficult to break when fished properly



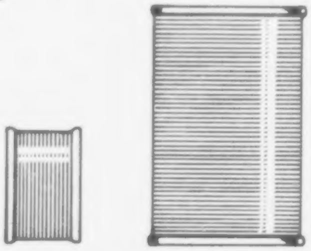
A small diameter line is best for maximum casting distance



Limper monofilament must be used on small diameter spinning reel spools

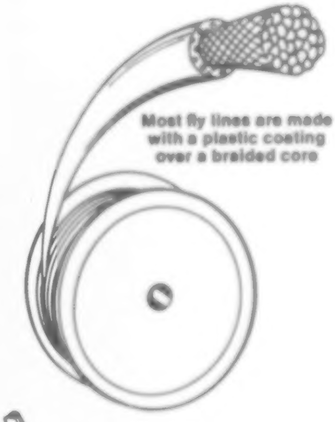
A wide range of knots with good strength can be used with monofilament

Knot strength is relative to the line strength



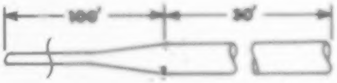
Monofilament line in small 100 yard spools or large bulk spools

fly line



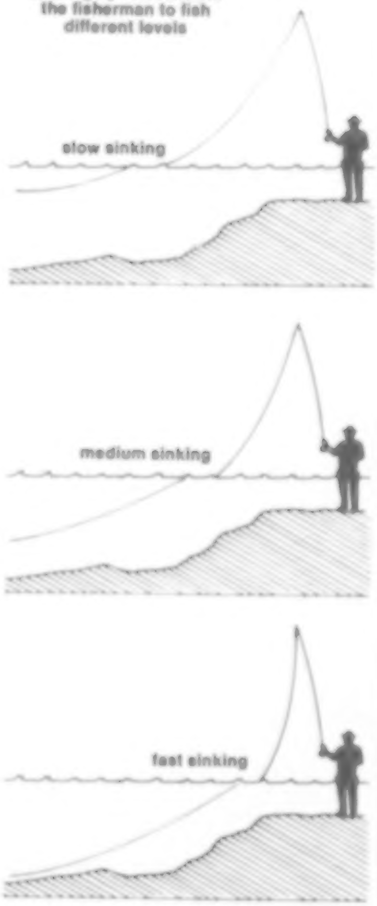
Most fly lines are made with a plastic coating over a braided core

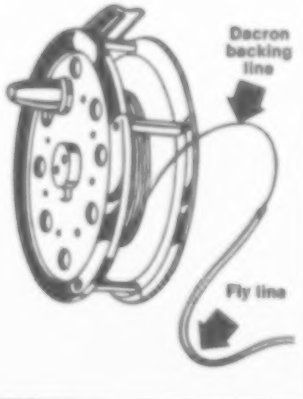
Most fly rods are marked with the proper line size for the rod



Weight-forward fly lines have a shooting head, usually 30 feet long

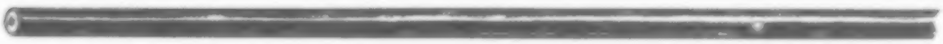
Sinking fly lines enable the fisherman to fish different levels


slow sinking
medium sinking
fast sinking

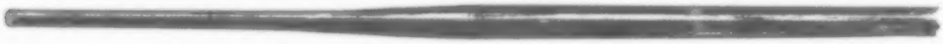

Dacron backing line
Fly line

Fly Line

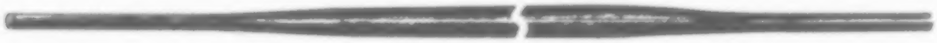
Level Line



Double Taper

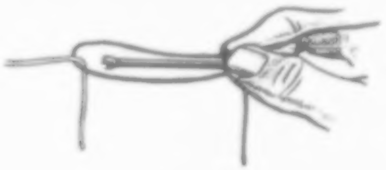


Weight Forward

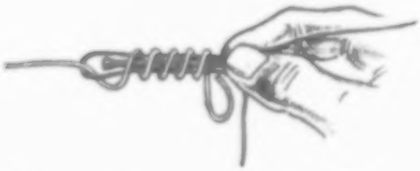


Nail Knot

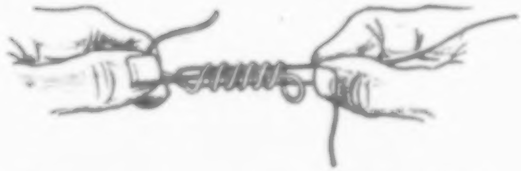
The nail knot was developed to splice backing or leaders to fly line. A small plastic or metal tube will work as well as a nail.



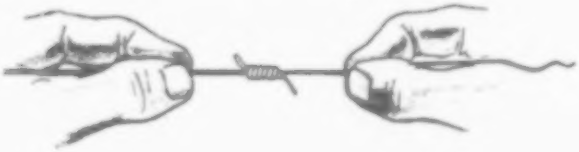
Pull at least six inches of fly line and lay the tube against it. Then fold the line back around the tube or nail. Take the end of the backing or leader and place it through the loop formed in the fly line.



Hold the line between your thumb and forefinger. Take the protruding end of the backing and wrap it loosely five to seven times back toward your thumb. Holding these coils so they won't overlap, bring the end of the backing and push it through the loose coils.



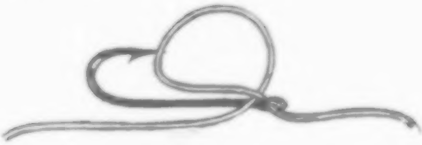
Holding the coils, carefully pull out the tube or nail, pulling the backing out as much as possible at the same time. With the tube pulled out, the coils will appear soft, but don't let go of them. Pull from both ends to gather the coils.



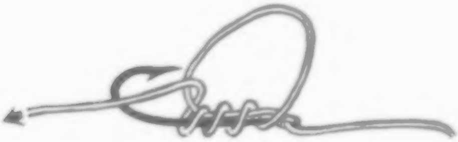
Adjust the coils as necessary and then pull hard on both ends to make the coils bite into the line. Tighten the knot and clip off the excess.

Common Knots

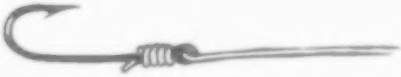
Snelling a Hook



1. Insert one end of leader material through eye of hook just past turn and barb. Pass other end through eye in opposite direction leaving large loop.

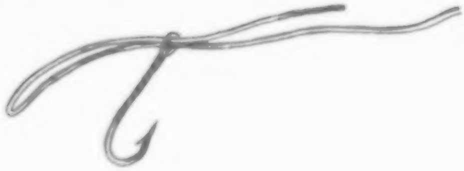


2. Hold both lines along shank. Use line hanging from eye to wind tight coils from eye toward hook, 5 to 10 turns.

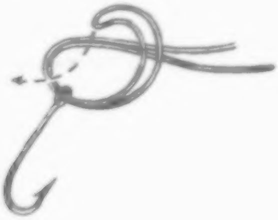


3. Move fingers to hold coils in place. Pull leader extending from eye until entire loop has passed under coils. With coils snugged up neatly, use pliers to pull tag end, clinching up snell. Clip tag end and tie loop knot in end of leader.

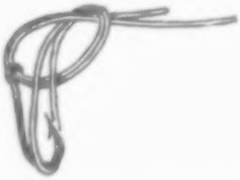
Palomar



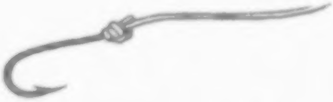
1. Double about 4 inches of line and pass loop through eye.



2. Let hook hang loose and tie overhand knot in doubled line.

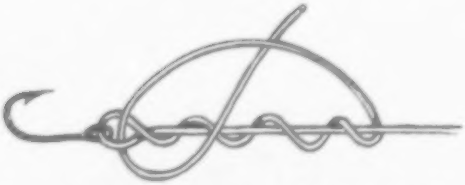


3. Pull loop of line far enough to pass over hook, swivel or lure.

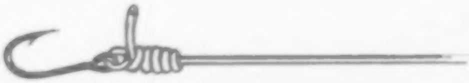


4. Pull tag end and standing line to tighten. Moisten before fully tightening. Clip tag end.

Clinch



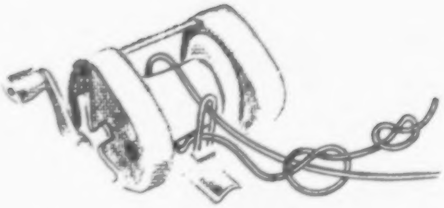
1. Pass line through eye of hook, swivel, or lure. Double back and make five turns around the standing line. Thread line through first loop above the eye, then through big loop as shown.



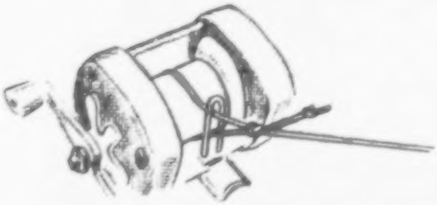
2. Hold tag end and standing line while coils are pulled up. Moisten and slide tight against eye. Clip tag end.

Common Knots

Arbor



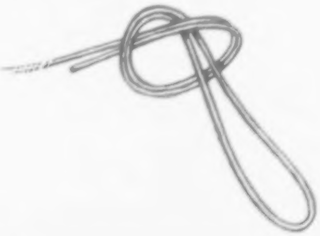
1. Thread line through line guide, around spool, and out through line guide. Tie overhand knot over standing line and in end of tag end.



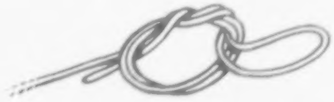
2. Tighten both knots. Pull on standing end until knot passes through line guide and snugs up around spool.

Surgeon's End Loop

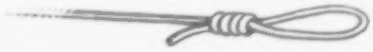
Use this knot to tie a loop in the end of a line to attach leaders or other terminal tackle.



1. Double end of line to form loop and tie overhand knot at base of double line.



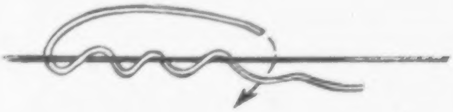
2. Leave loop open in knot and bring doubled line through once more.



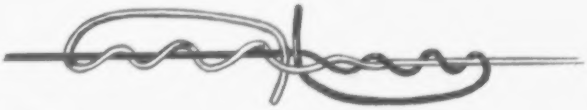
3. Hold standing end and tag end and pull loop to tighten knot.

Blood

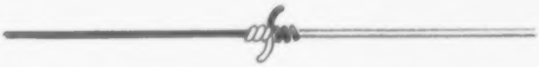
Used to join two lines together.



1. Overlap ends of the two lines for about 6 inches. Take tag end of one line and make 6 turns around the two lines. Take tag end and insert between tag end of other line and standing end of the line being manipulated. Hold on to tag end and repeat procedure for other line.



2. Pull each tag end to begin to tighten knot.

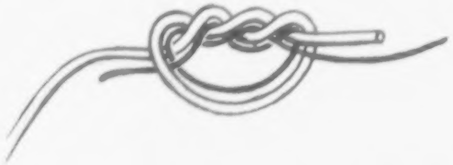


3. Moisten knot. Tighten completely and clip tag ends.

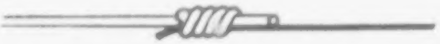
Surgeon's Knot

Joins leader to line. Good when lines vary in diameter.

1. Lay line parallel, overlapping 6 to 8 inches. Treating the two like a single line tie an overhand knot, pulling entire leader through loop.



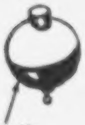
2. Leaving loop of overhand knot open, pull both tag end of line and leader through again, shown above.



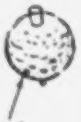
3. Moisten and tighten knot. Clip tag ends.

Terminal Tackle

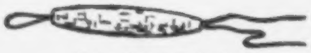
Floats or Bobbers



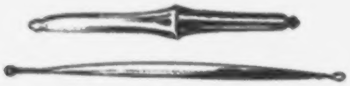
Plastic



Cork

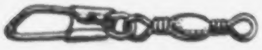


Card-Line Float

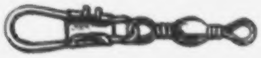


Pencil and Quill

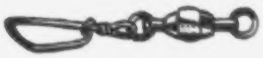
Snap Swivels



Snap/Swivel

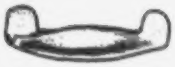


Interlock Snap/Swivel

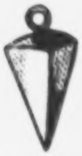


Lock Snap
Ball Bearing Swivel

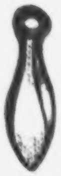
Sinkers



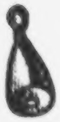
Clincher



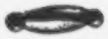
Pyramid



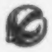
Bank



Dipsy



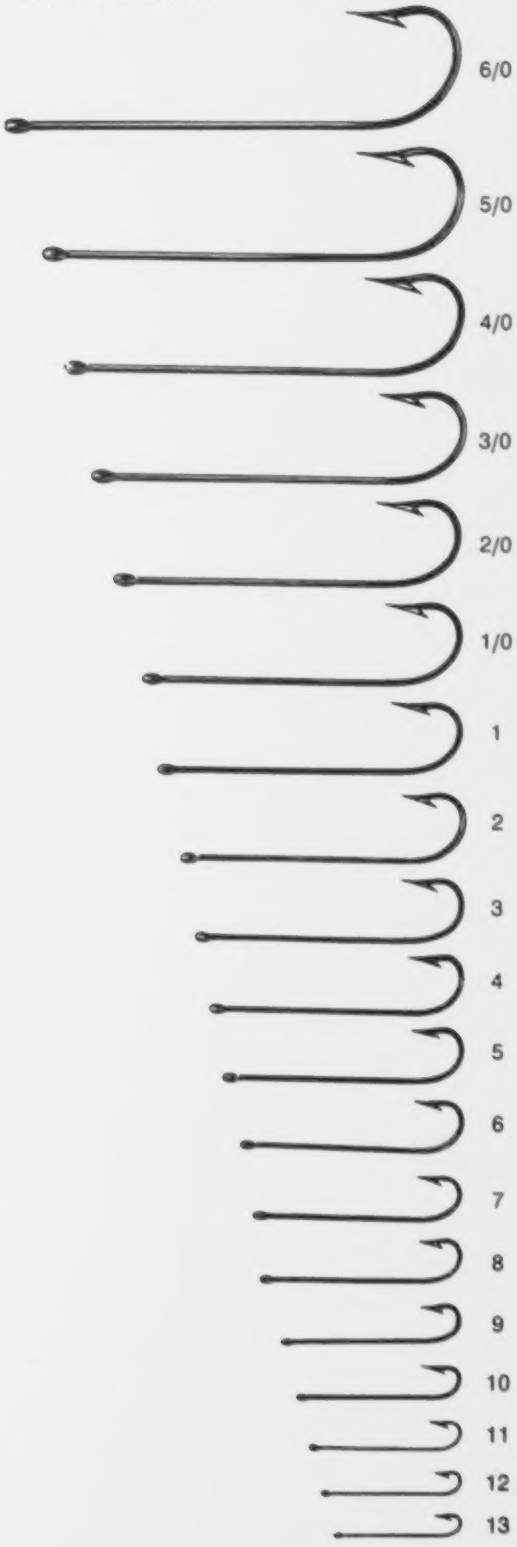
Rubber Core



Split Shot

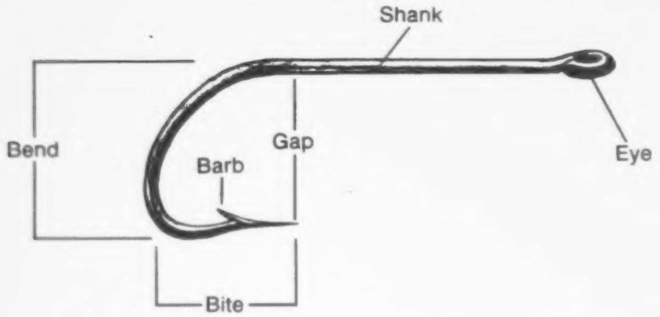
Hook Sizes

Carlisle Hook Size Chart

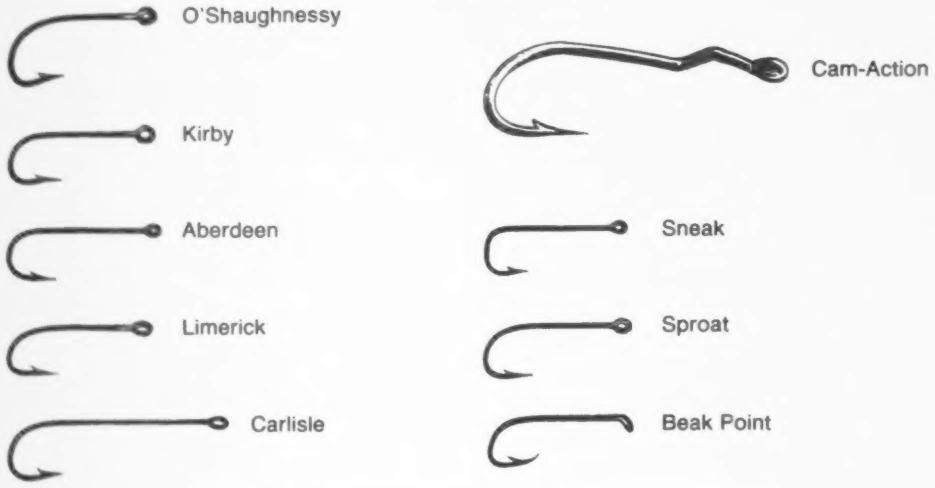

6/0
5/0
4/0
3/0
2/0
1/0
1
2
3
4
5
6
7
8
9
10
11
12
13

Fish Hooks

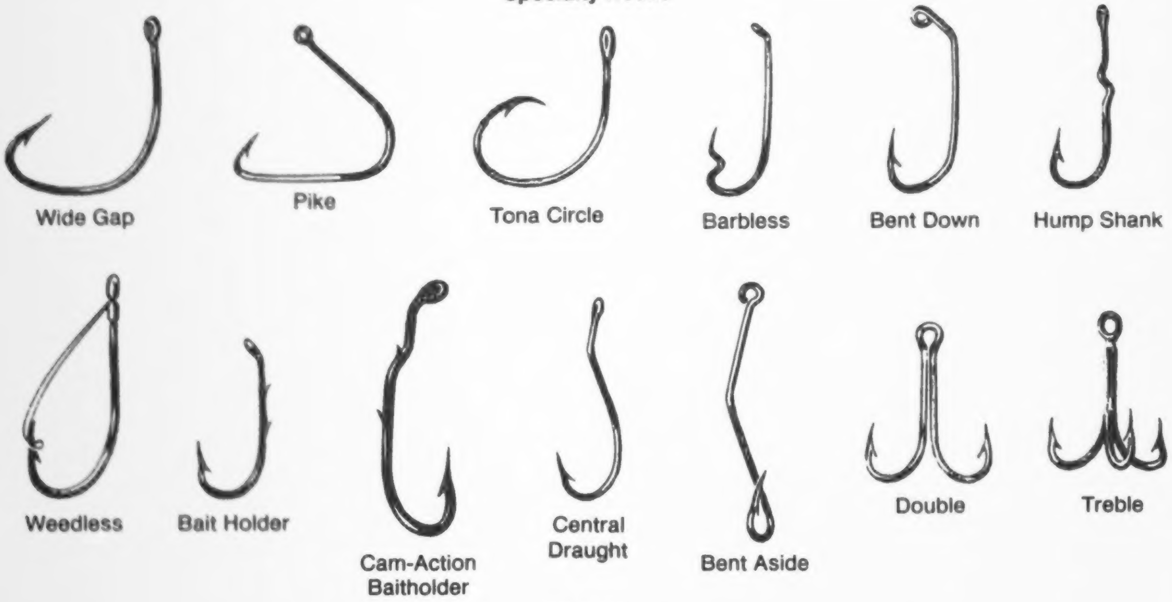
Anatomy of A Fish Hook


Shank
Bend
Gap
Barb
Eye
Bite

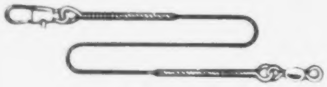
Types of Fish Hooks

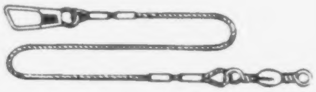

O'Shaughnessy
Cam-Action
Kirby
Aberdeen
Sneak
Limerick
Sproat
Carlisle
Beak Point

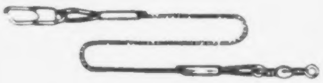
Specialty Hooks

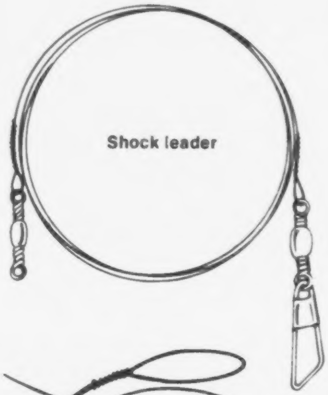

Wide Gap
Pike
Tona Circle
Barbless
Bent Down
Hump Shank
Weedless
Bait Holder
Cam-Action Baitholder
Central Draught
Bent Aside
Double
Treble

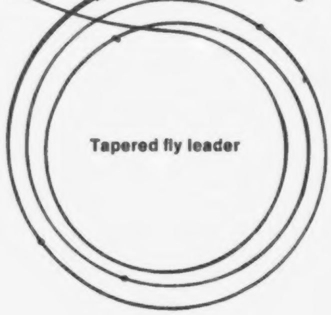
leaders


Solid wire

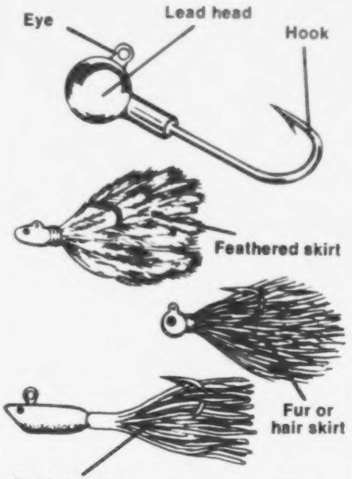

Braided wire

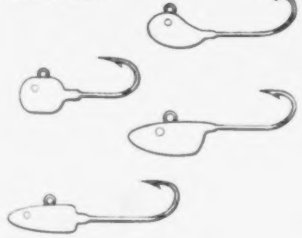

Nylon covered wire

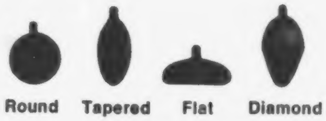

Shock leader

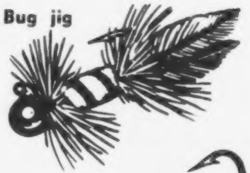

Tapered fly leader

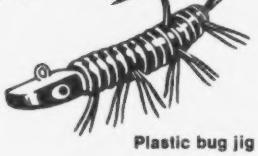
jigs


Eye
Lead head
Hook
Feathered skirt
Fur or hair skirt
Rubber skirt


Assorted jig heads

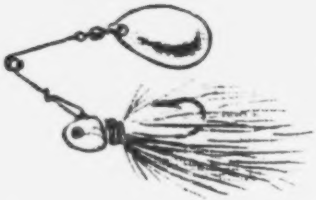

Round
Tapered
Flat
Diamond

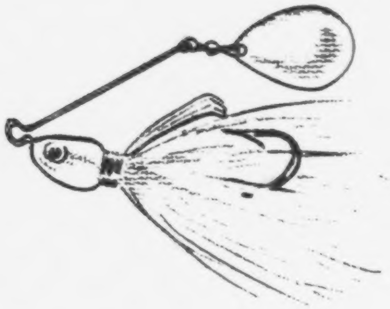


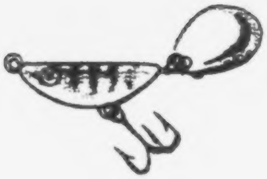

Plastic bug jig

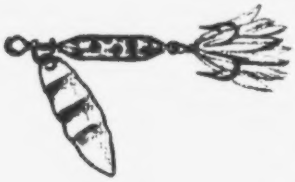
Artificial Lures

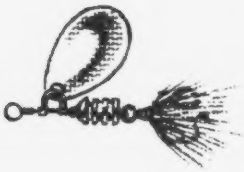
Spinners



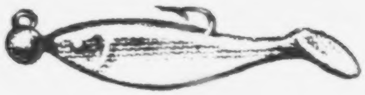


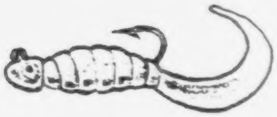


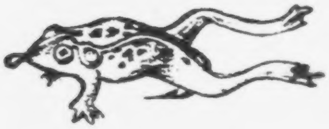


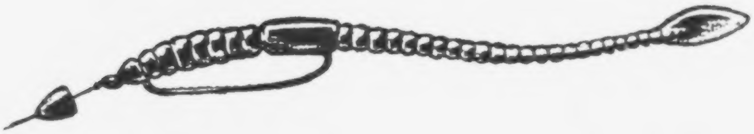


Soft Plastics

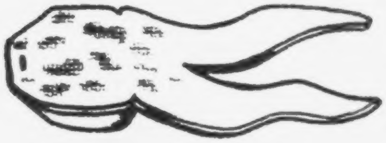




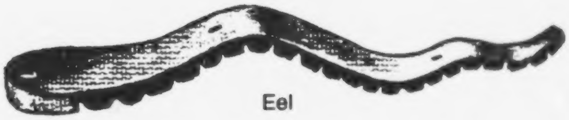




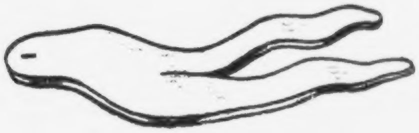
Pork Rind Baits



Frog

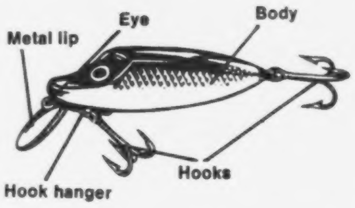


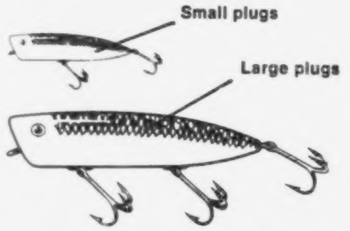
Eel

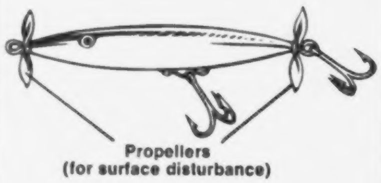


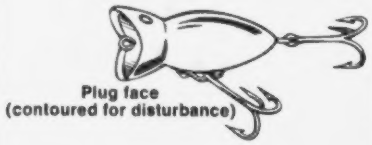
Spin Strip

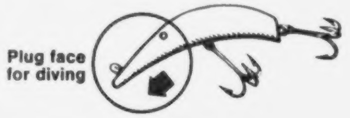
plugs

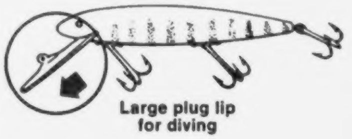

Eye
Body
Metal lip
Hooks
Hook hanger

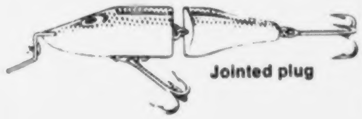

Small plugs
Large plugs


Propellers
(for surface disturbance)

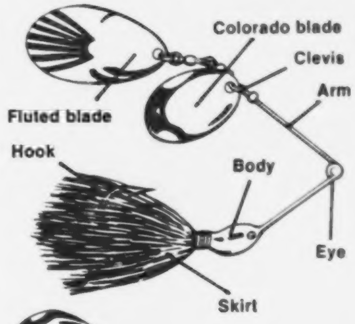

Plug face
(contoured for disturbance)

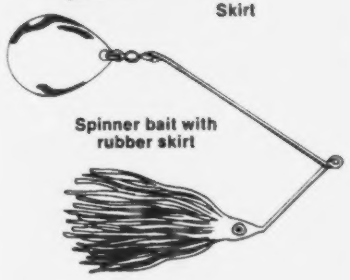

Plug face
for diving

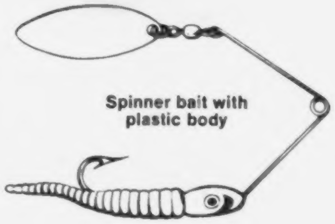

Large plug lip
for diving

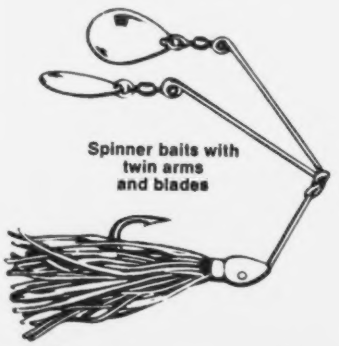

Jointed plug

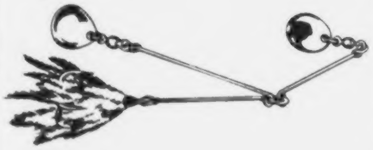
spinner baits


Colorado blade
Clevis
Arm
Fluted blade
Hook
Body
Eye
Skirt

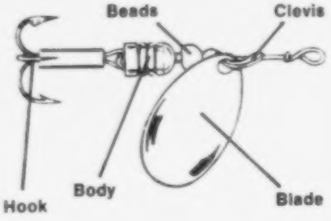

Spinner bait with
rubber skirt

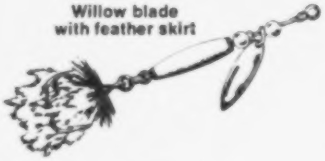

Spinner bait with
plastic body

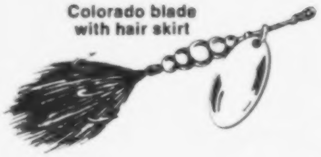

Spinner baits with
twin arms
and blades

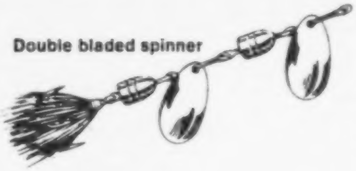


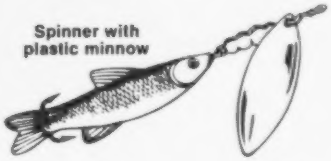
spinners

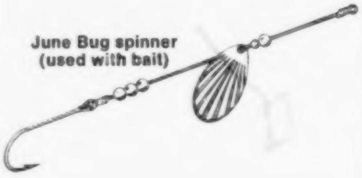

Beads
Clevis
Hook
Body
Blade


Willow blade with feather skirt

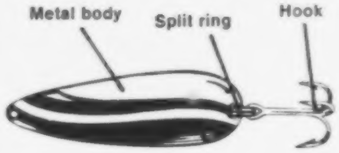

Colorado blade with hair skirt

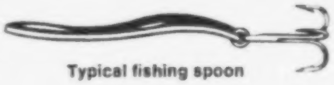

Double bladed spinner

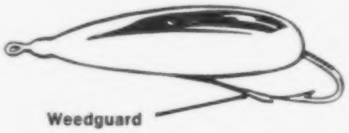

Spinner with plastic minnow

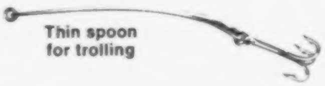

June Bug spinner (used with bait)

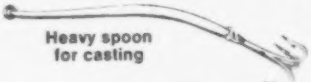
spoons

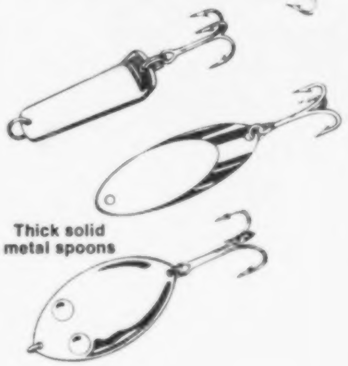

Metal body
Split ring
Hook

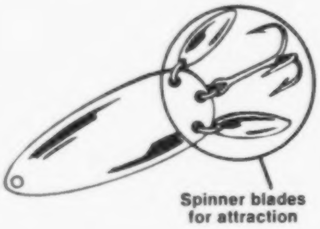

Typical fishing spoon




Thin spoon for trolling

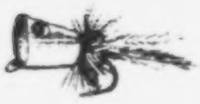

Heavy spoon for casting


Thick solid metal spoons

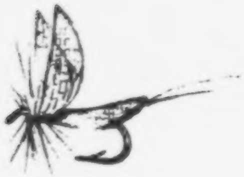

Spinner blades for attraction

Lures for Fly Fishing

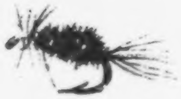
Popper



Dry Fly

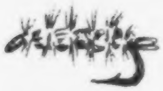


Gauzewing

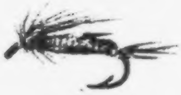


Hackle

Wet Fly

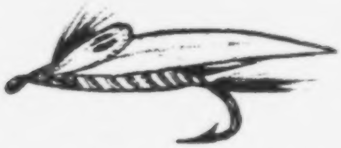


Wooly Worm

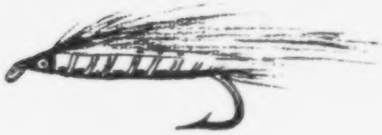


Hackle

Streamer

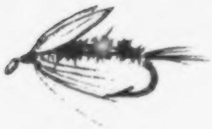


Feather Streamer



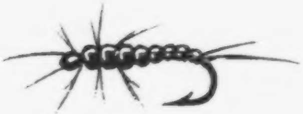
Bucktail

Wet or Dry



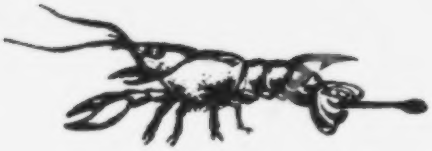
March Brown

Nymph

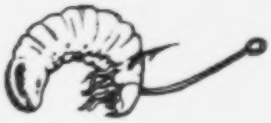


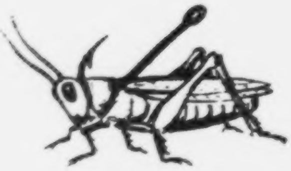
Stonefly Nymph

Methods of Hooking Live Bait

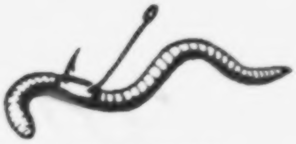


Crawdad

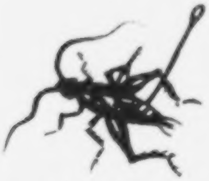




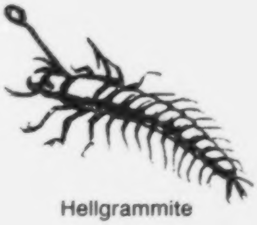
Grasshopper



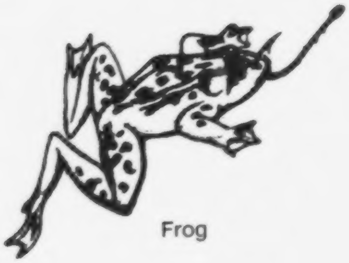
Night Crawler



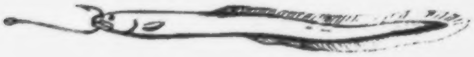
Cricket

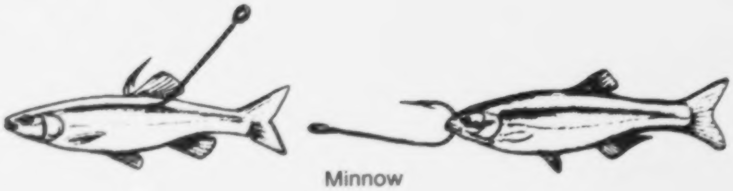


Hellgrammite

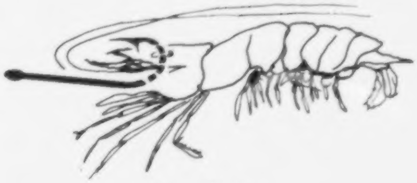


Frog

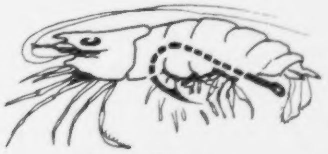




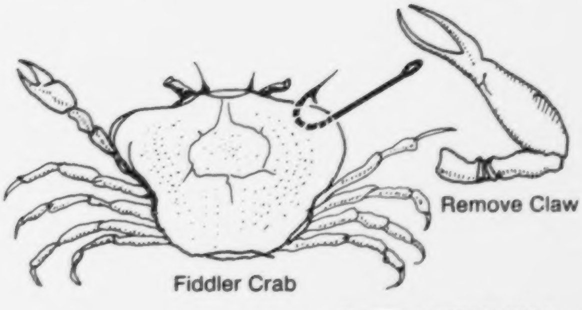
Minnow



Live Shrimp



Dead Shrimp



Remove Claw

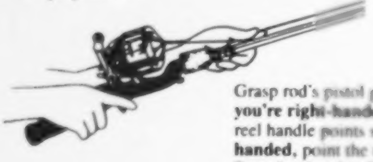
Fiddler Crab

Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

Casting Techniques

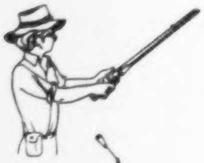
SPINCASTING

Use two hands to cast with spincasting equipment:



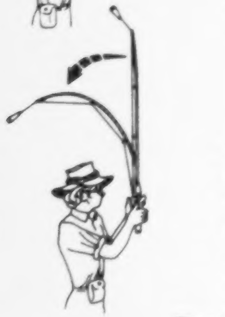
1.

Grasp rod's pistol grip with one hand. **If you're right-handed,** turn rod sideways so the reel handle points straight up; **if you're left-handed,** point the reel handle straight down. Put other hand in front of reel, and hold the line lightly between thumb and forefinger. Push reel's thumb button down and hold it down.



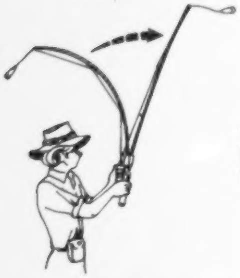
2.

Face target area with body turned at slight angle—about a quarter turn. Arm holding rod handle should be closest to target. Aim rod tip toward the target—about level with your eyes.



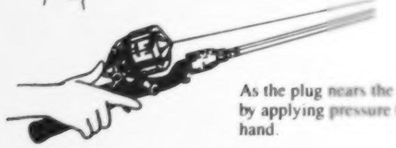
3.

Swiftly and smoothly, bend your casting arm at the elbow, raising your casting forearm until your hands reach eye level. When the rod is almost straight up, it will be bent back by the weight of the practice plug. As rod bends, move both forearms forward at once with just a slight wrist movement.



4.

When rod reaches eye level, **release** the thumb button and let the line travel freely through the fingers of your line hand.



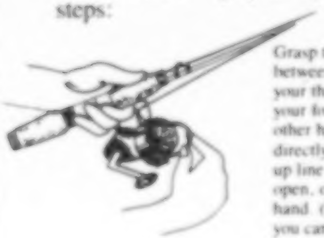
5.

As the plug nears the target, **slow** it gradually by applying pressure to the line with your hand.

If the lure landed close in front of you, you released the spincast reel's thumb button too late. If the lure went more or less straight up, you released the button too soon.

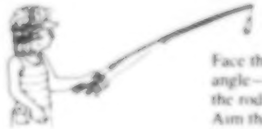
SPINNING

To cast using spinning tackle, follow these steps:



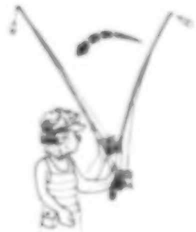
1.

Grasp the rod's handle, placing the reel "stem" between your second and third fingers. Place your thumb on top of the handle and extend your forefinger to touch the spool cover. With other hand, rotate reel spool until line roller is directly beneath your extended forefinger. Pick up line in front of roller with forefinger and open, or cock, the reel's bail with your other hand. (Note: Some new reels have a lever so you can grasp the line and open the bail in one motion.)



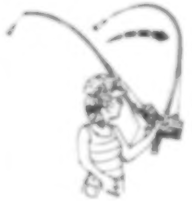
2.

Face the target area with body turned at slight angle—about a quarter turn. The arm holding the rod handle should be closest to the target. Aim the rod tip toward the target at about eye level.



3.

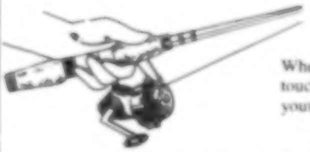
Swiftly and smoothly, using just one motion, bend your casting arm at the elbow and raise your casting forearm so your hand is almost at eye level.



4.

When the rod is almost vertical, it will be bent by the weight of the practice plug. As the rod bends, move your forearm forward with a slight wrist movement.

When the rod reaches eye level, straighten your forefinger to release the line. As the plug nears the target, slow it gradually by touching the line coming off the reel with your forefinger.



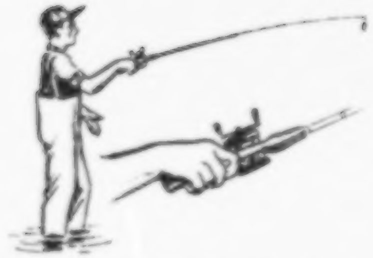
5.

When the plug is over the target, stop it by touching the top edge of the reel's spool with your forefinger.

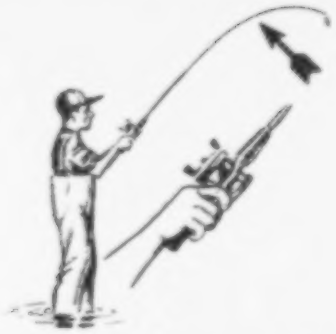
If the lure landed close in front of you, your forefinger released the line too late. If the plug went more or less straight up, you released your forefinger too soon.

Don't be discouraged if your first casts don't go as planned. In casting—no matter what kind of fishing tackle you use—timing is critical for long, accurate casts, and you will improve with practice.

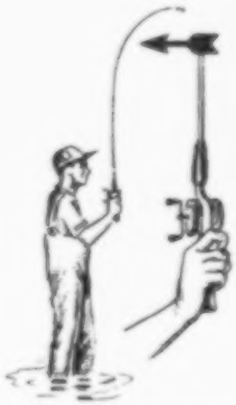
Casting with Bait Casting Equipment



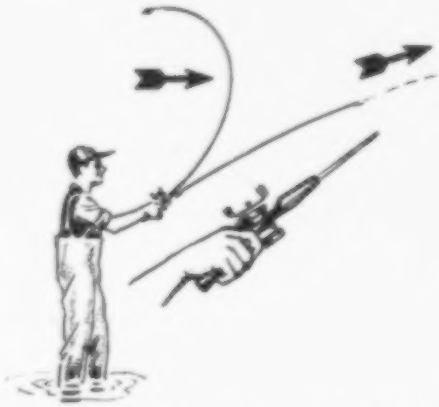
Press the spool release button and rest your thumb on the line. Hold the rod as shown with the reel handles pointed up (down if left-handed).



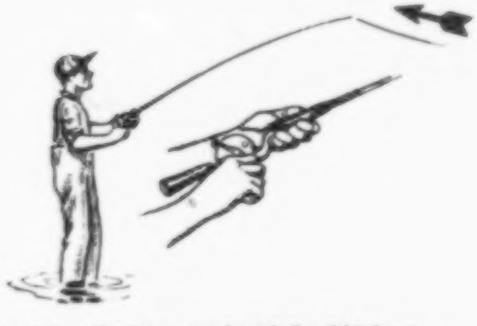
Cocking your arm, lift the rod until it just "splits" your target (about 10 o'clock). Your elbow should be clear of your body, slightly above and in front of your hips. Start the cast by bringing the rod swiftly backward toward a vertical position.



Continue the swift backward movement. The reel handle should be toward the body and just below eye level.

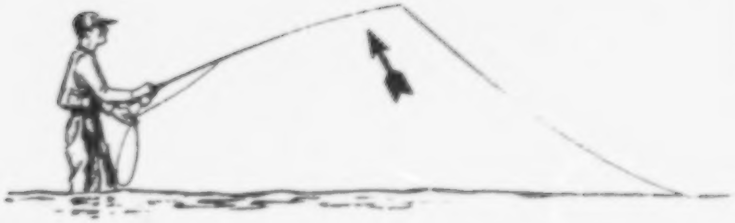


As the rod approaches a vertical position it will develop a bend from the weight of the lure. When the rod reaches a 1 o'clock position, without hesitation begin the down-stroke, using a slight wrist-twist for added power. As the rod reaches the 11 o'clock position, ease off on the thumb pressure. Use the thumb for braking to avoid backlash.

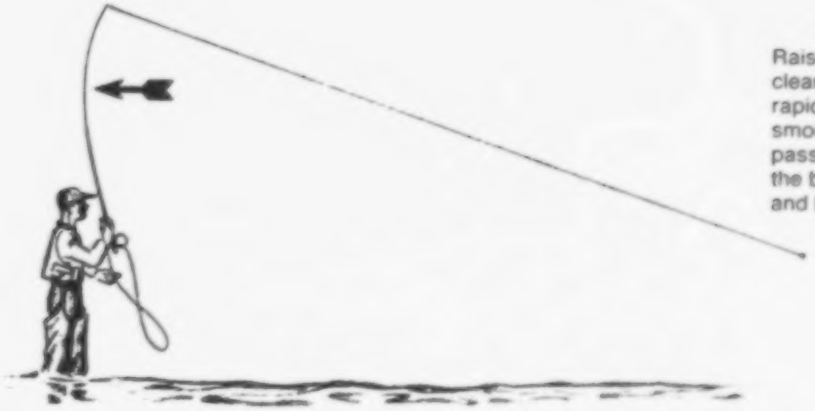


To retrieve the lure, one hand should take a combination hold on the feel, forward grip, and line, while the other hand turns the handle.

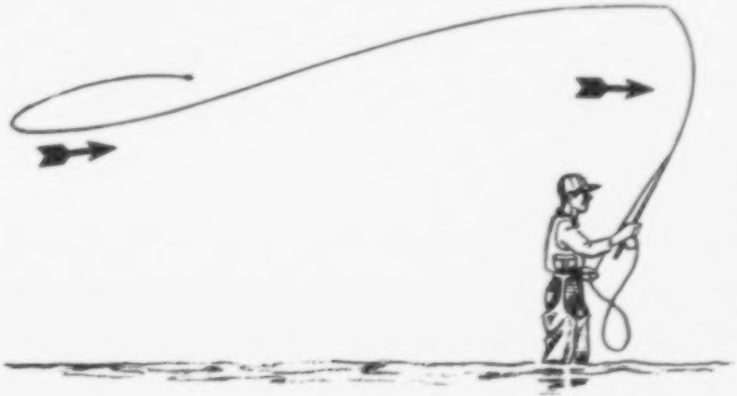
Casting with Fly Fishing Equipment



Before beginning the cast, strip 20 or so feet of line from the reel and place in front. Strip additional line near the casters feet. Begin the back cast with a smooth, even lift-off. Don't jerk.



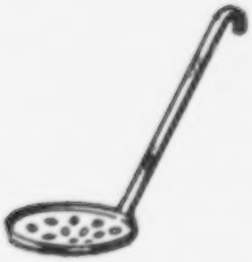
Raise the rod until the leader is almost clear of the water. A slow-starting, rapidly-accelerating movement will smoothly pick up the line. As the rod passes the 11 o'clock point, speed up the backward motion and flip the line up and back.

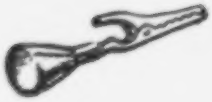


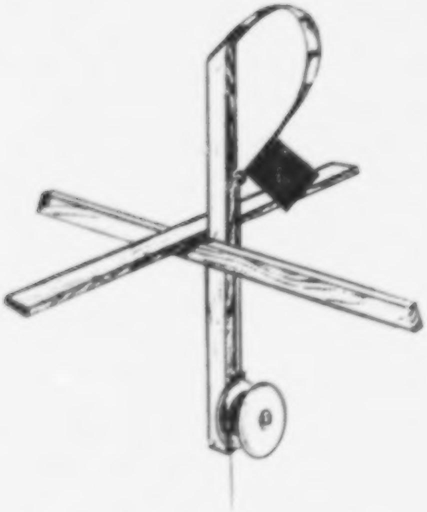
Stop the rod hard at 1 o'clock. Open the wrist enough to allow the rod to drift back with the weight of the line. Turn your head and watch the line as it loops and rolls out behind. When the backcast is rolled almost out to its end, begin the forward cast. Move the rod smoothly. Stop the action at 11 o'clock.

Give it a final little flip to get extra footage and let the casting hand follow through with the casting stroke.

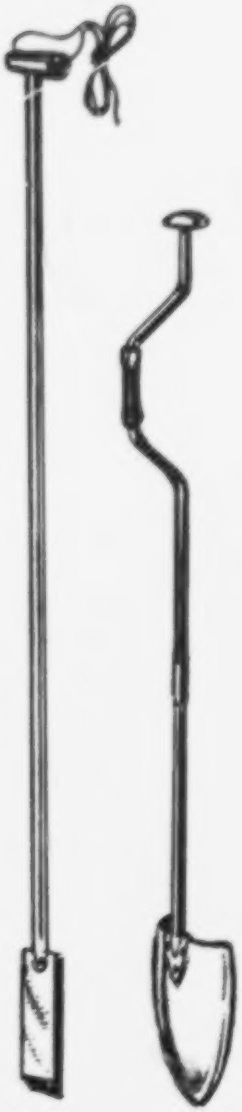
Ice Fishing Equipment





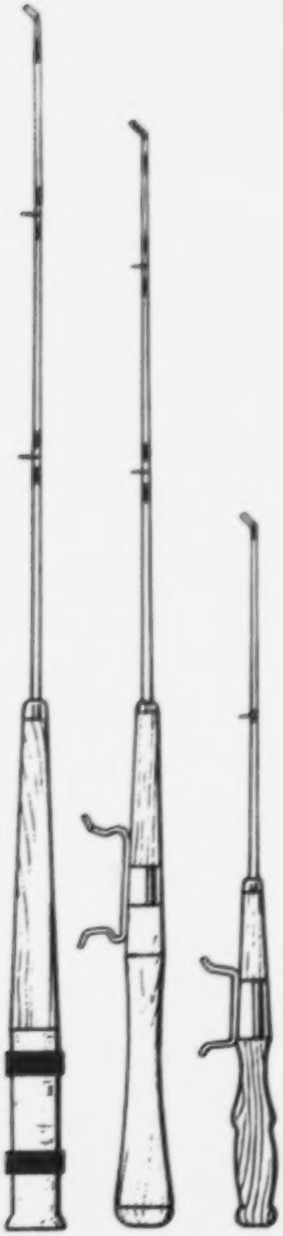


Underwater Tip-Up



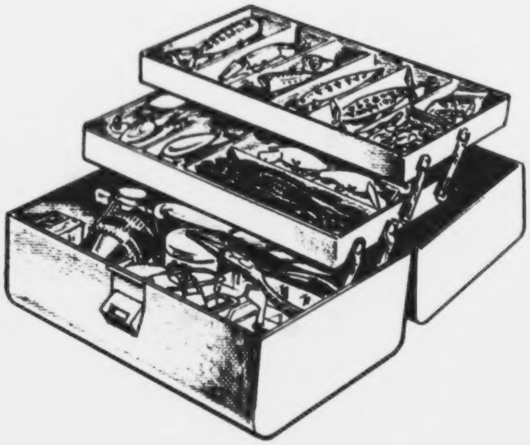
Spud

Auger

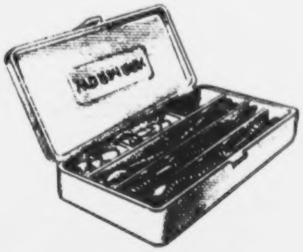


Fishing Equipment

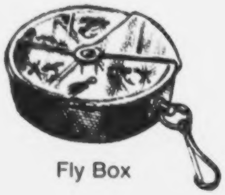
Tackle Box



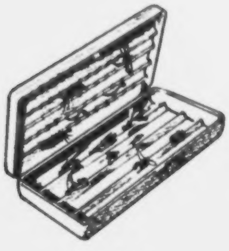
Specialty Tackle Boxes



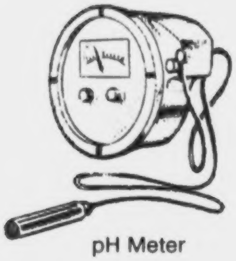
Worm Box



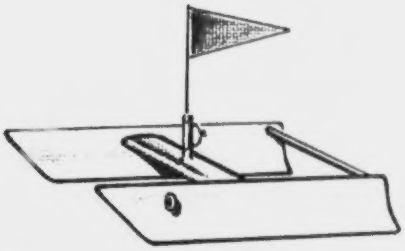
Fly Box



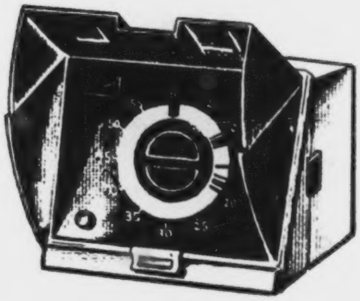
Fly Box



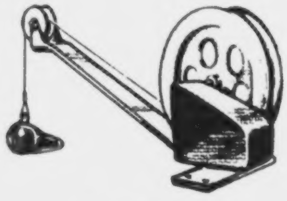
pH Meter



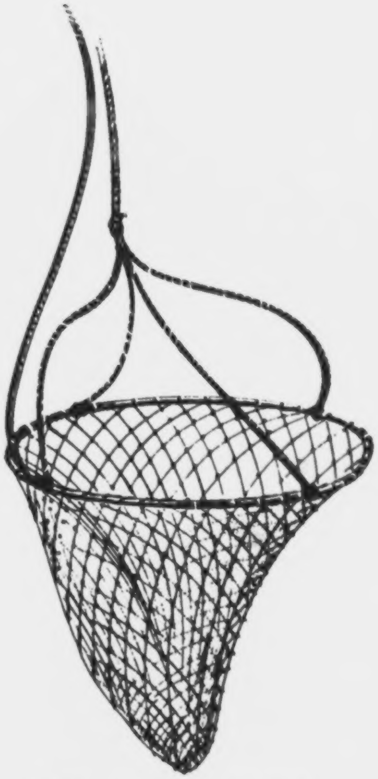
Side Planer



Flasher Style Depth Finder

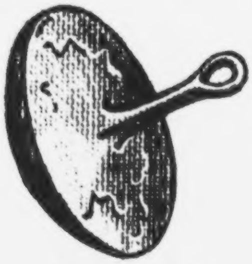


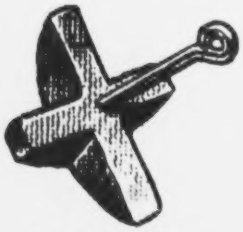
Downrigger

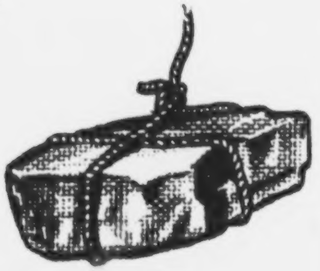


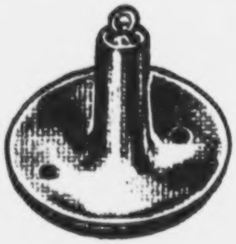
Bridge or Pier Landing Net

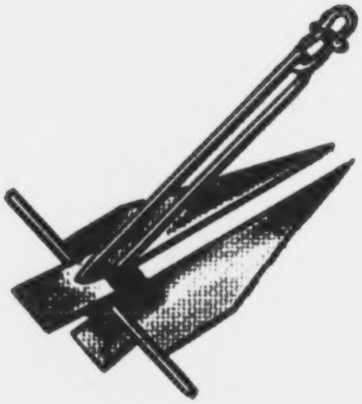
Anchors


Leaded Hubcap

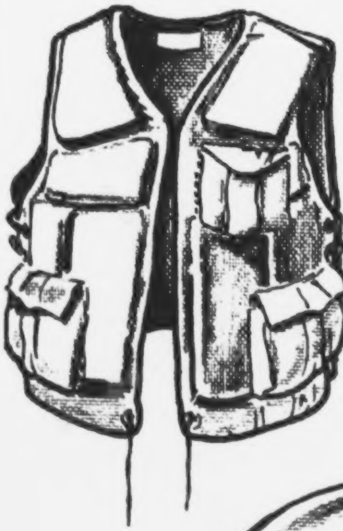

Vinyl Coated Cross

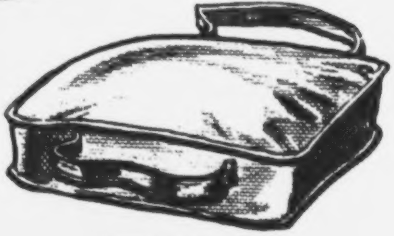

Rock

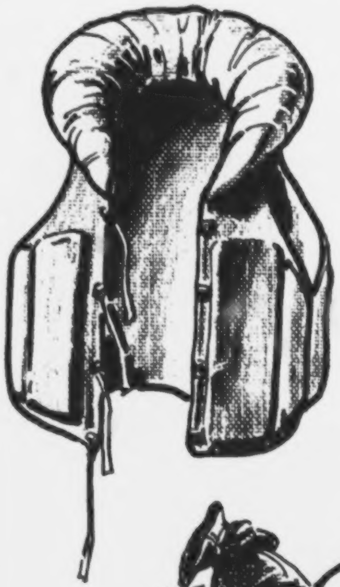

Mushroom

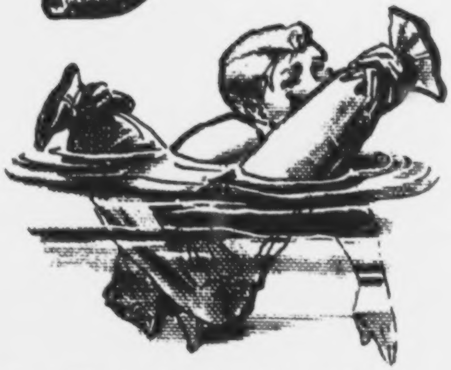

Danforth

Personal Flotation Devices (PFD's)



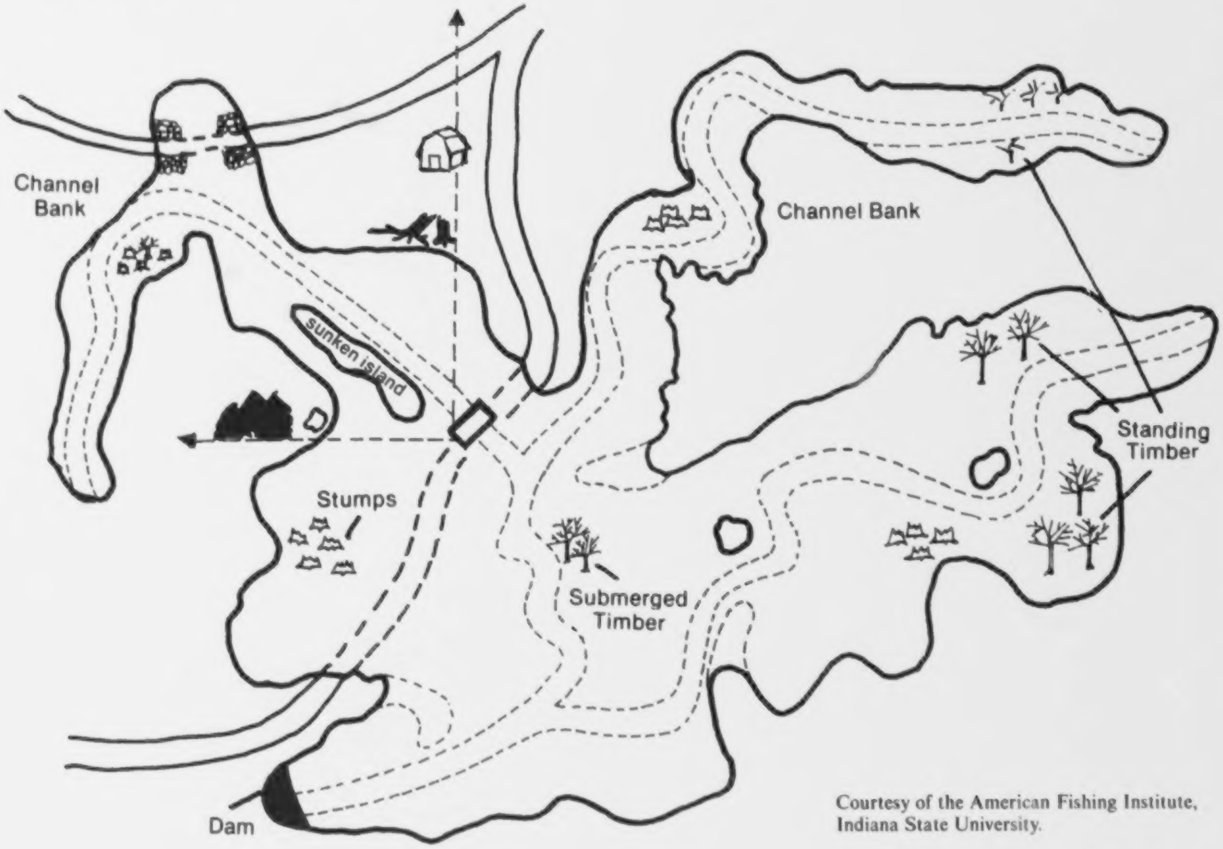

Boat Cushion Type




Emergency--Tie pant legs together and fill with air.

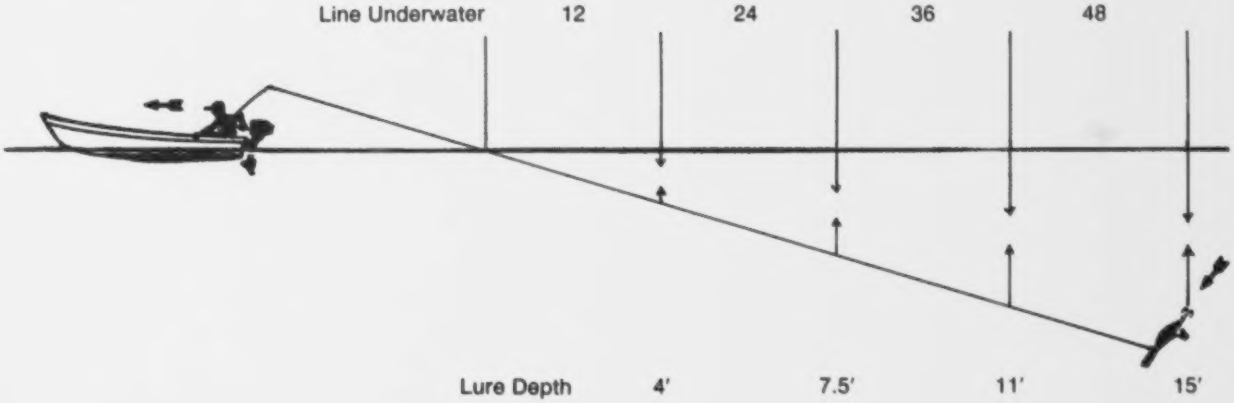
Locating Fish and Fishing Areas

Cross Triangulation


Channel Bank
sunken island
Channel Bank
Stumps
Submerged Timber
Standing Timber
Dam

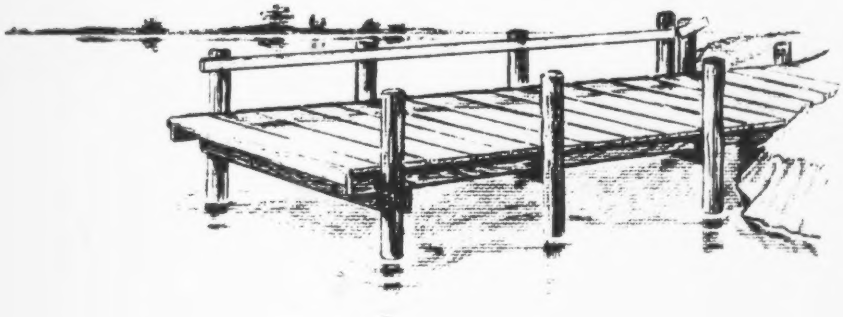
Courtesy of the American Fishing Institute,
Indiana State University.

Trolling

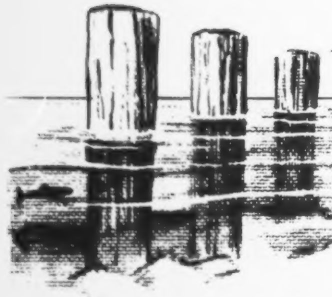

Line Underwater
12
24
36
48
Lure Depth
4'
7.5'
11'
15'

The amount of line out during trolling helps determine the depth of the lure.

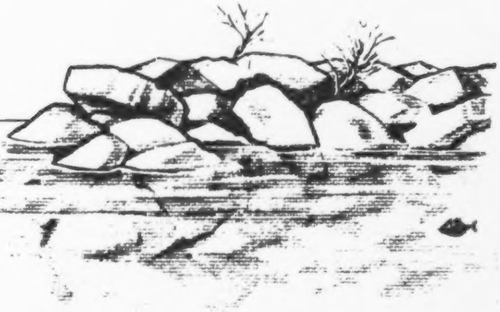
Good Fishing Areas



Dock

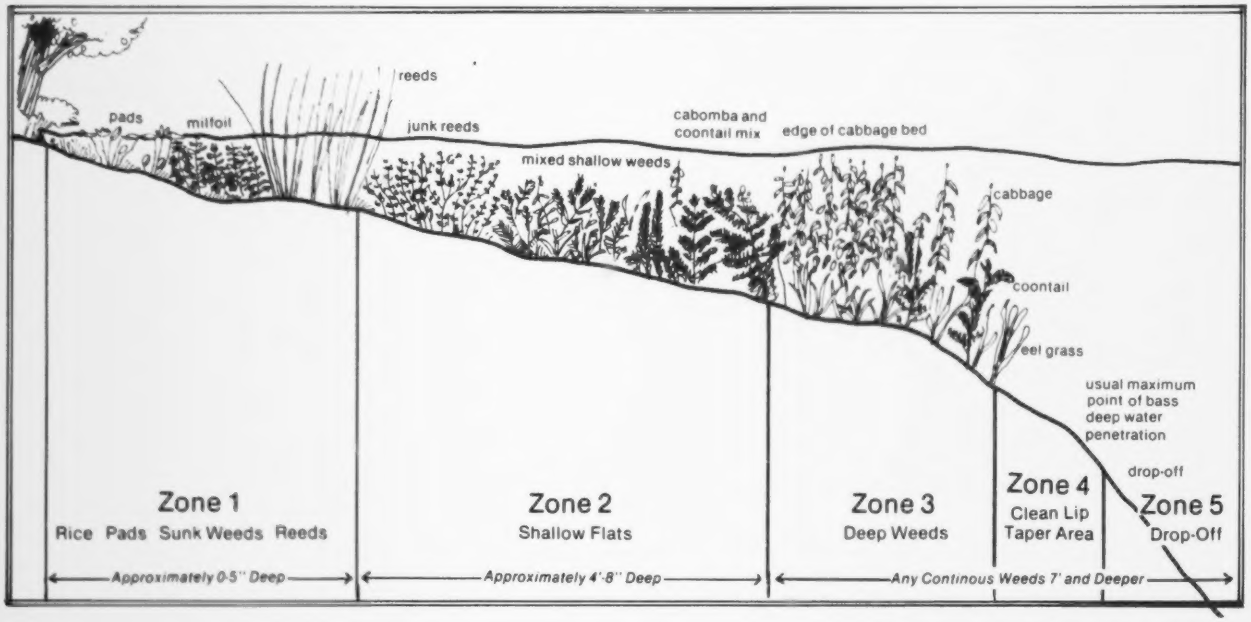


Piling



Jetty

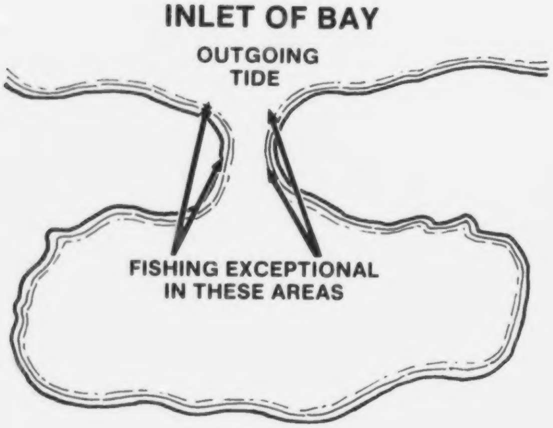
Typical Cross Section of Weed Zones

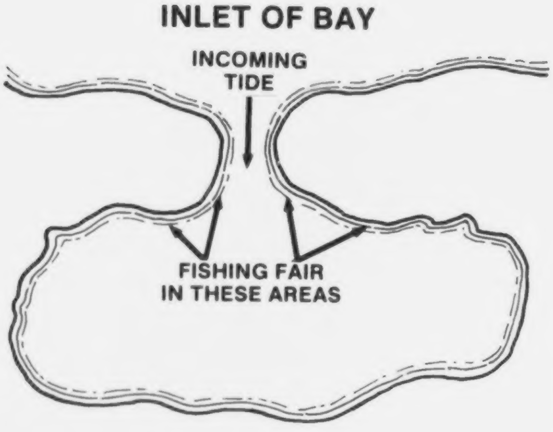

reeds
pads
milfoil
junk reeds
cabomba and coontail mix
edge of cabbage bed
mixed shallow weeds
cabbage
coontail
eel grass
usual maximum point of bass deep water penetration
drop-off
Zone 1
Rice Pads Sunk Weeds Reeds
Zone 2
Shallow Flats
Zone 3
Deep Weeds
Zone 4
Clean Lip Taper Area
Zone 5
Drop-Off
Approximately 0-5'' Deep
Approximately 4'-8'' Deep
Any Continous Weeds 7' and Deeper

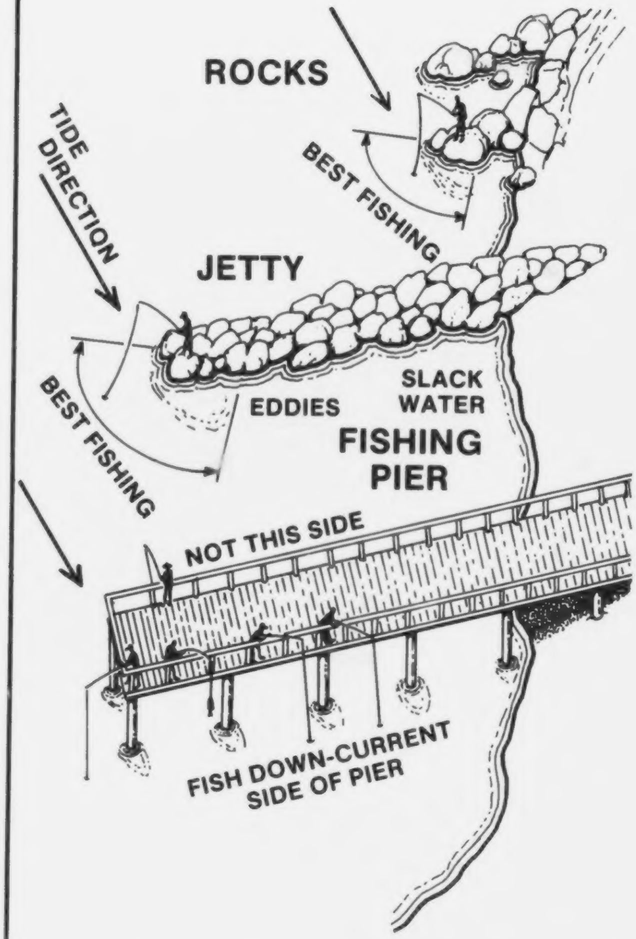
Courtesy of In' Fisherman Magazine.

Shore Fishing

Salt Water

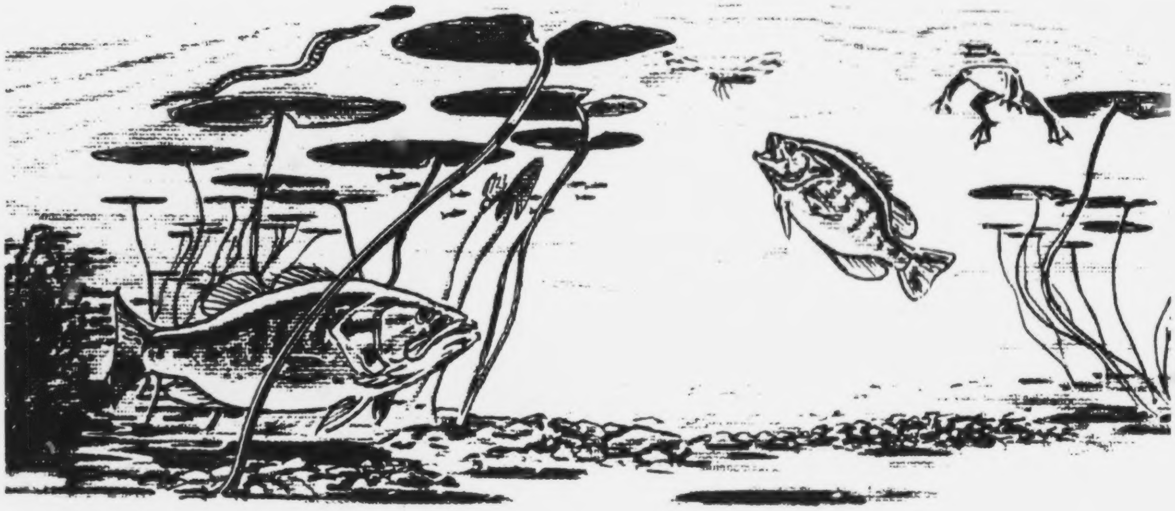

INLET OF BAY
OUTGOING TIDE
FISHING EXCEPTIONAL IN THESE AREAS

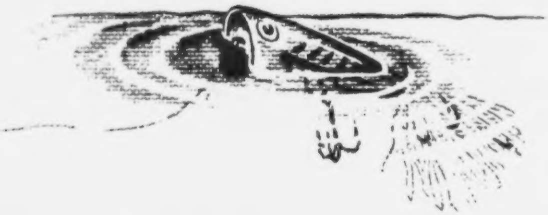

INLET OF BAY
INCOMING TIDE
FISHING FAIR IN THESE AREAS


ROCKS
TIDE DIRECTION
BEST FISHING
JETTY
BEST FISHING
EDDIES
SLACK WATER
FISHING PIER
NOT THIS SIDE
FISH DOWN-CURRENT SIDE OF PIER

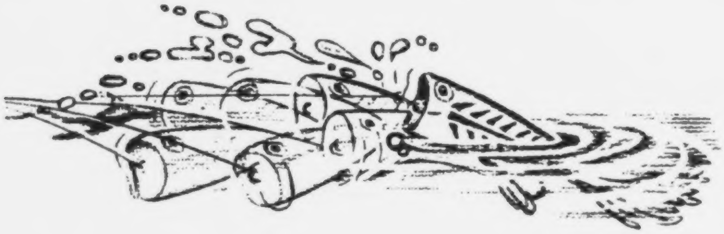
Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

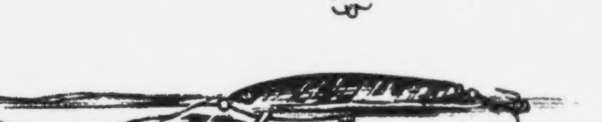
Water Surface as Fishing Area

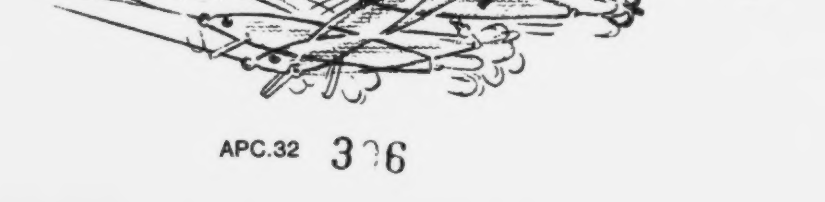




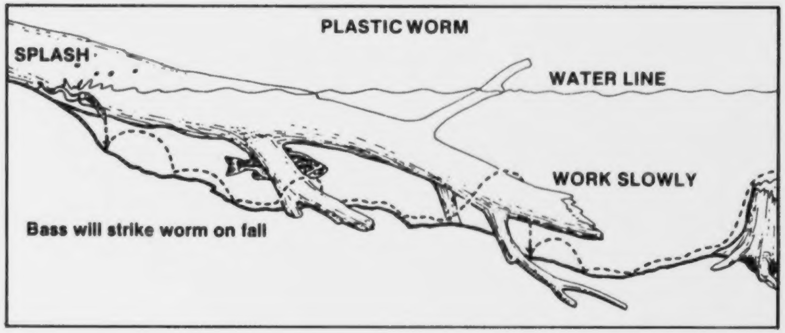
Many fish feed on the surface. After casting out a surface lure, allow the ripples to subside. Then twitch the lure or give the rod a swift, quick snap. The lure will not only create sound, but will also simulate a wounded fish. This action will attract a predator. After the ripples subside again, repeat the process.

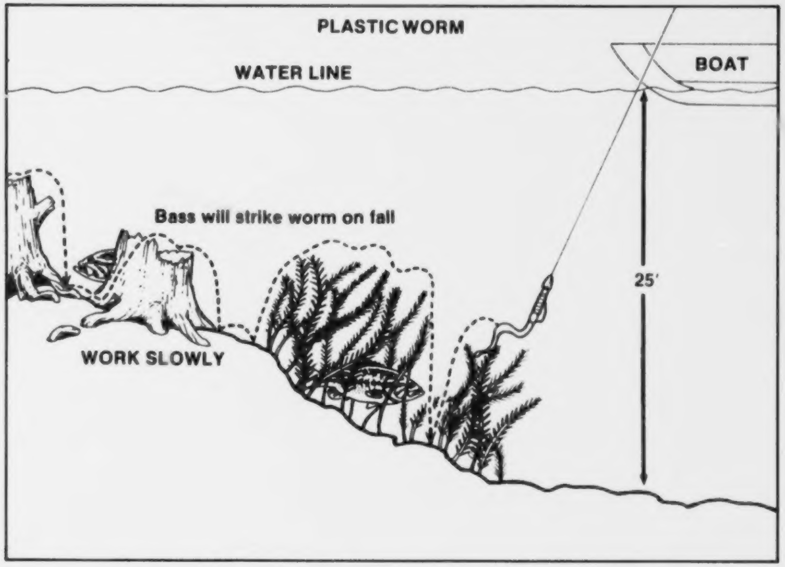


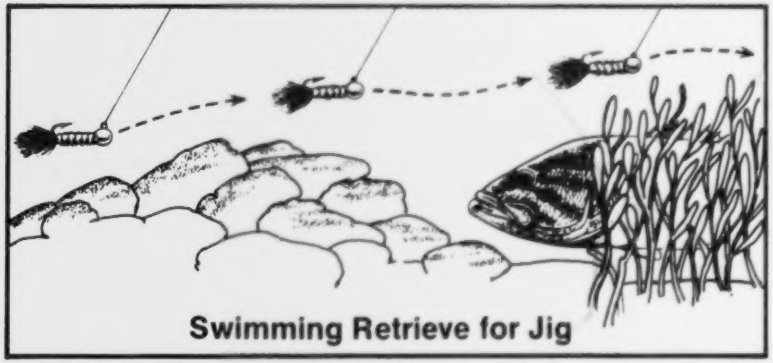


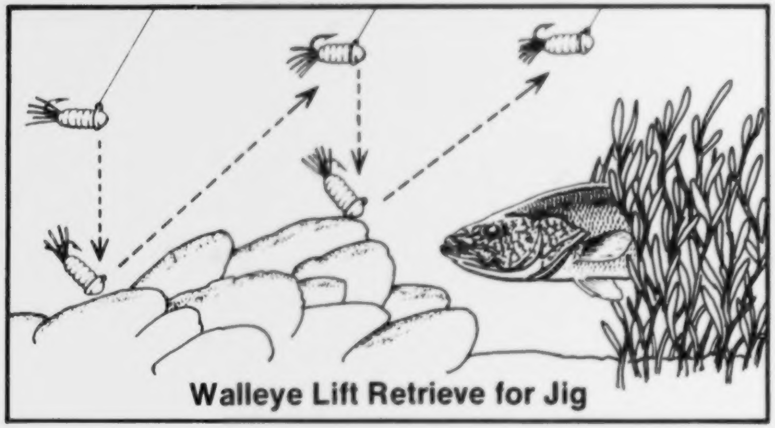


Lure Techniques


PLASTIC WORM
SPLASH
WATER LINE
WORK SLOWLY
Bass will strike worm on fall

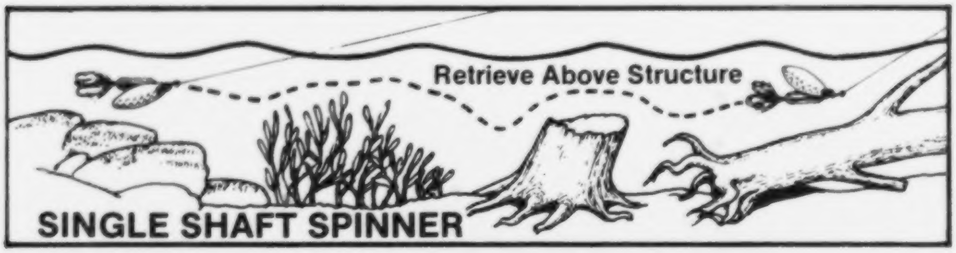

PLASTIC WORM
WATER LINE
BOAT
Bass will strike worm on fall
25'
WORK SLOWLY

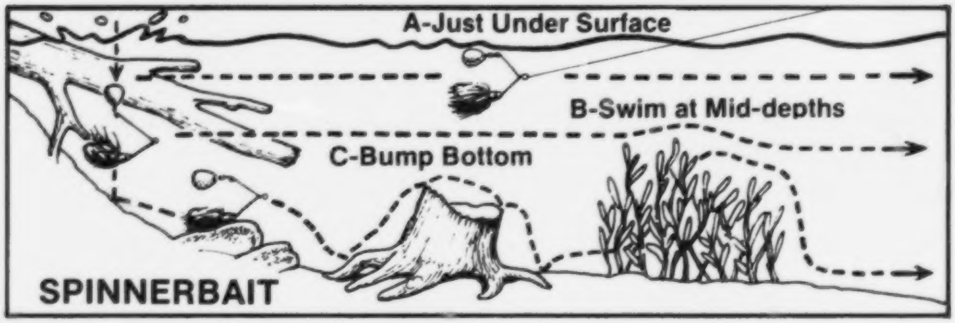

Swimming Retrieve for Jig

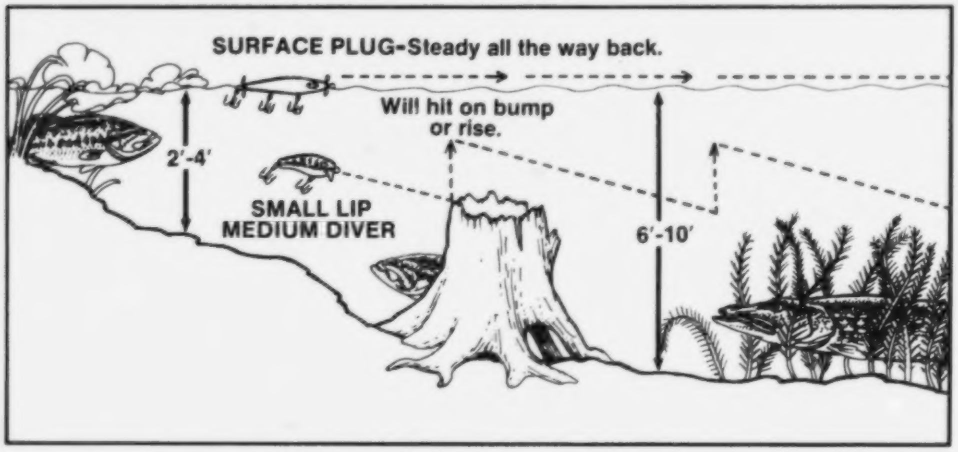

Walleye Lift Retrieve for Jig

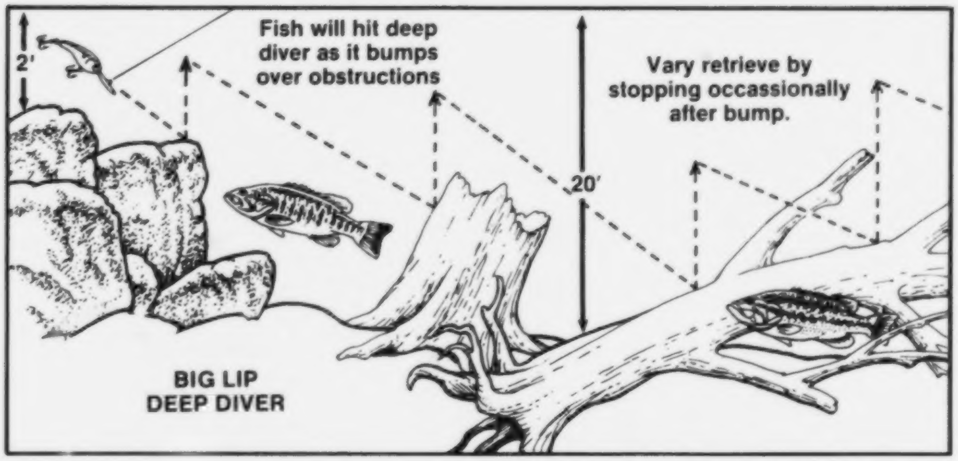
Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

Lure Techniques


Retrieve Above Structure
SINGLE SHAFT SPINNER

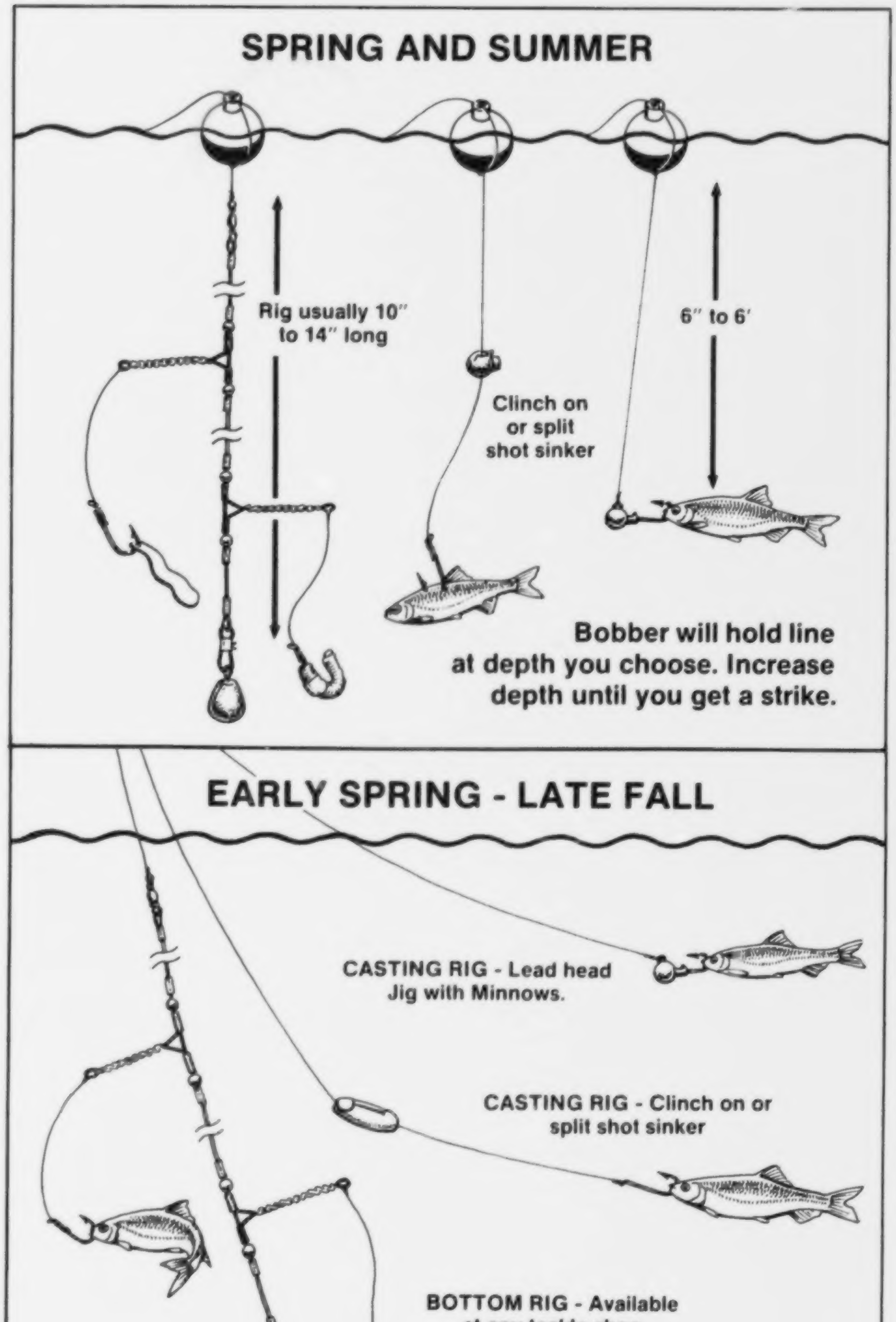

A-Just Under Surface
B-Swim at Mid-depths
C-Bump Bottom
SPINNERBAIT


SURFACE PLUG-Steady all the way back.
Will hit on bump or rise.
2'-4'
SMALL LIP MEDIUM DIVER
6'-10'


2'
Fish will hit deep diver as it bumps over obstructions
20'
Vary retrieve by stopping occassionally after bump.
BIG LIP DEEP DIVER

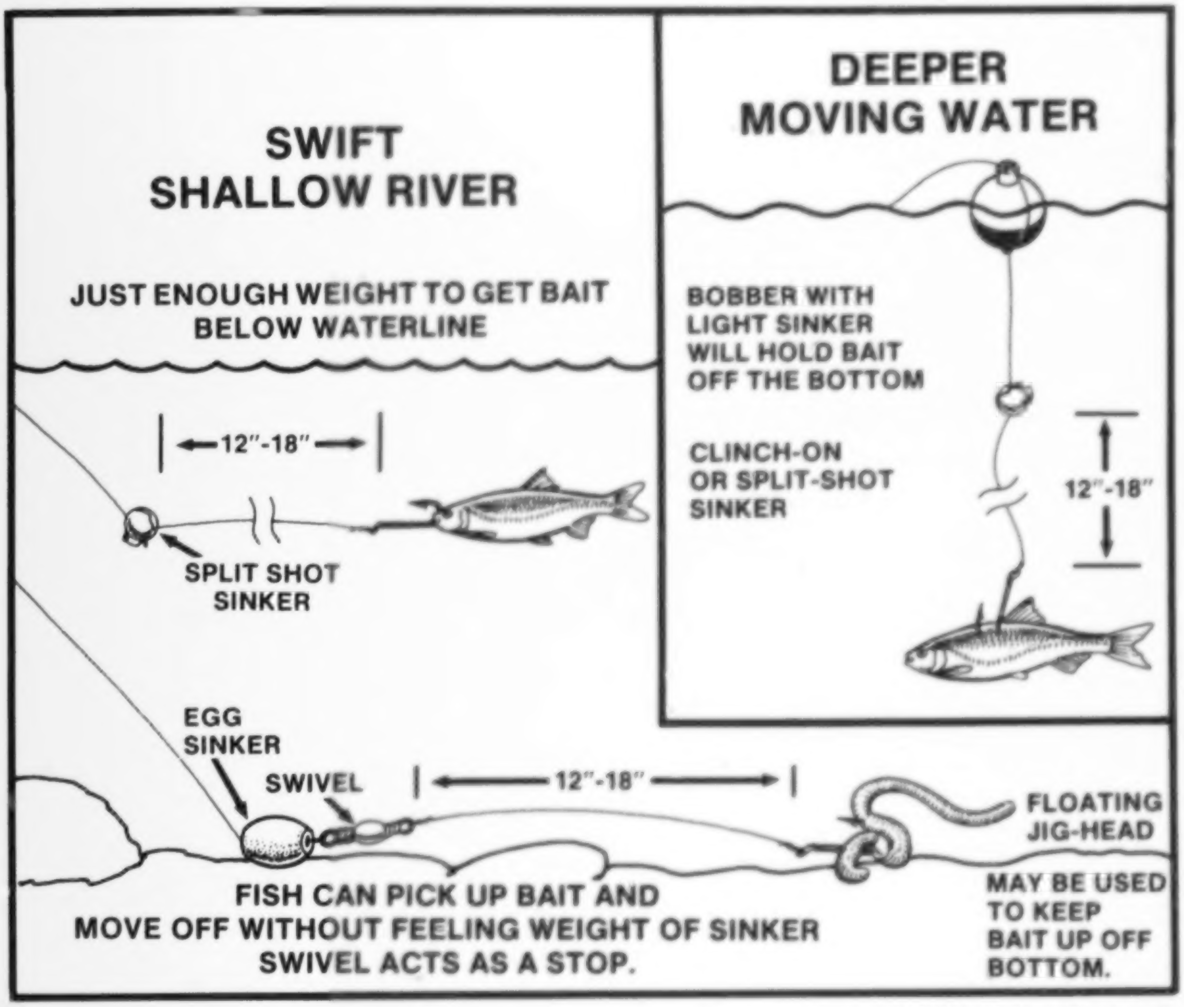
Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

Fishing Rigs—Freshwater


SPRING AND SUMMER
Rig usually 10" to 14" long
6" to 6'
Clinch on or split shot sinker
Bobber will hold line at depth you choose. Increase depth until you get a strike.
EARLY SPRING - LATE FALL
CASTING RIG - Lead head Jig with Minnows.
CASTING RIG - Clinch on or split shot sinker
BOTTOM RIG - Available at any tackle shop

Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

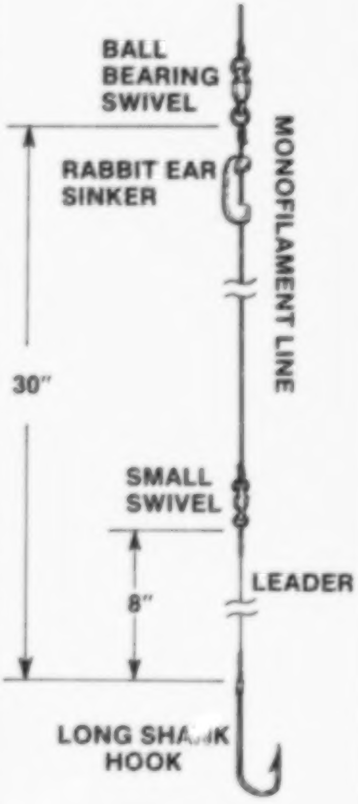
Fishing Rigs for Moving Water


SWIFT SHALLOW RIVER
JUST ENOUGH WEIGHT TO GET BAIT BELOW WATERLINE
12"-18"
SPLIT SHOT SINKER
EGG SINKER
SWIVEL
12"-18"
FLOATING JIG-HEAD
MAY BE USED TO KEEP BAIT UP OFF BOTTOM.
FISH CAN PICK UP BAIT AND MOVE OFF WITHOUT FEELING WEIGHT OF SINKER SWIVEL ACTS AS A STOP.
DEEPER MOVING WATER
BOBBER WITH LIGHT SINKER WILL HOLD BAIT OFF THE BOTTOM
CLINCH-ON OR SPLIT-SHOT SINKER
12"-18"

Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

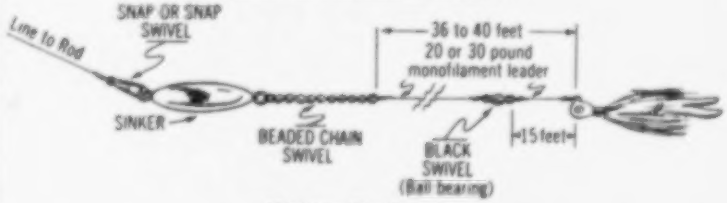
Fishing Rigs—Saltwater

Chumming Rig


BALL BEARING SWIVEL
RABBIT EAR SINKER
MONOFILAMENT LINE
30"
SMALL SWIVEL
8"
LEADER
LONG SHANK HOOK

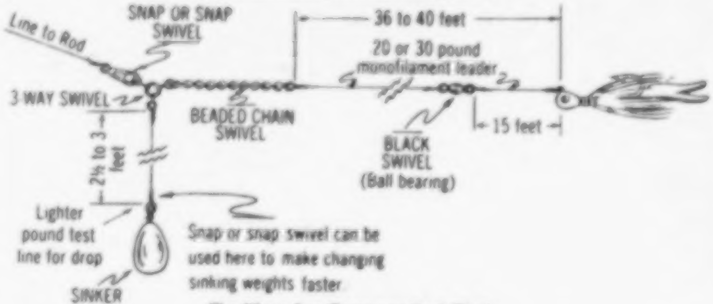
Trolling Rigs

IN-LINE SINKER RIG


Line to Rod
SNAP OR SNAP SWIVEL
SINKER
BEADED CHAIN SWIVEL
36 to 40 feet
20 or 30 pound monofilament leader
BLACK SWIVEL (Ball bearing)
15 feet

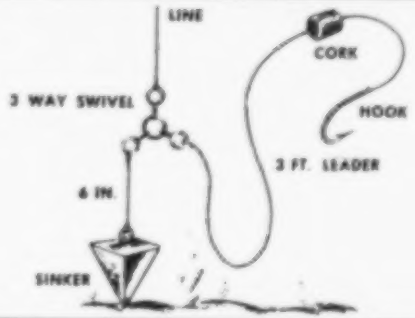
Bottom Trolling Rig

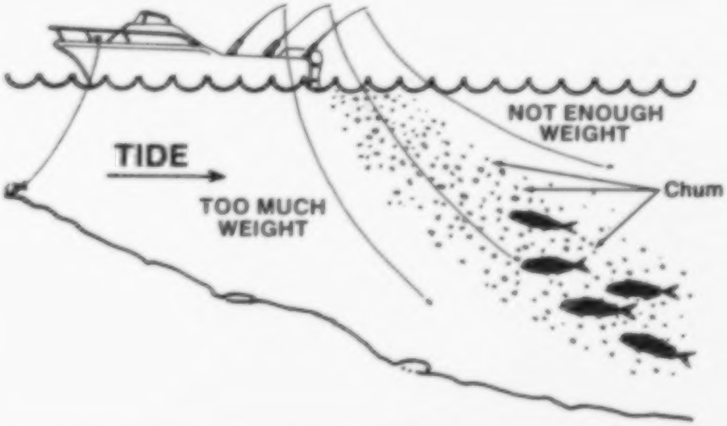
DROP SINKER RIG


Line to Rod
SNAP OR SNAP SWIVEL
3 WAY SWIVEL
BEADED CHAIN SWIVEL
36 to 40 feet
20 or 30 pound monofilament leader
BLACK SWIVEL (Ball bearing)
15 feet
2½ to 3 feet
Lighter pound test line for drop
Snap or snap swivel can be used here to make changing sinking weights faster
SINKER

Trolling for Suspended Fish

Bottom Rig

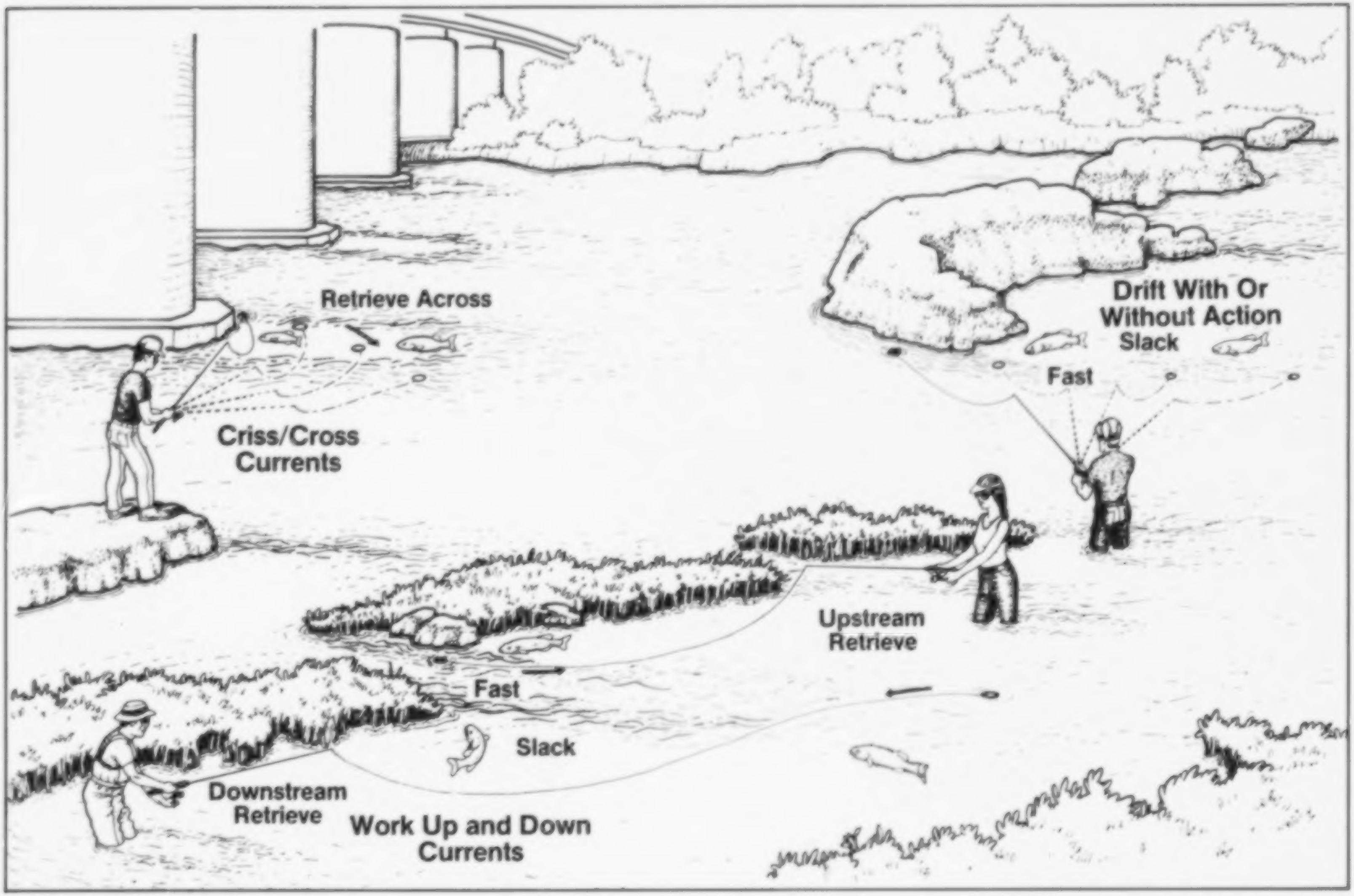

LINE
CORK
3 WAY SWIVEL
HOOK
3 FT. LEADER
6 IN.
SINKER


NOT ENOUGH WEIGHT
TIDE
Chum
TOO MUCH WEIGHT

Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

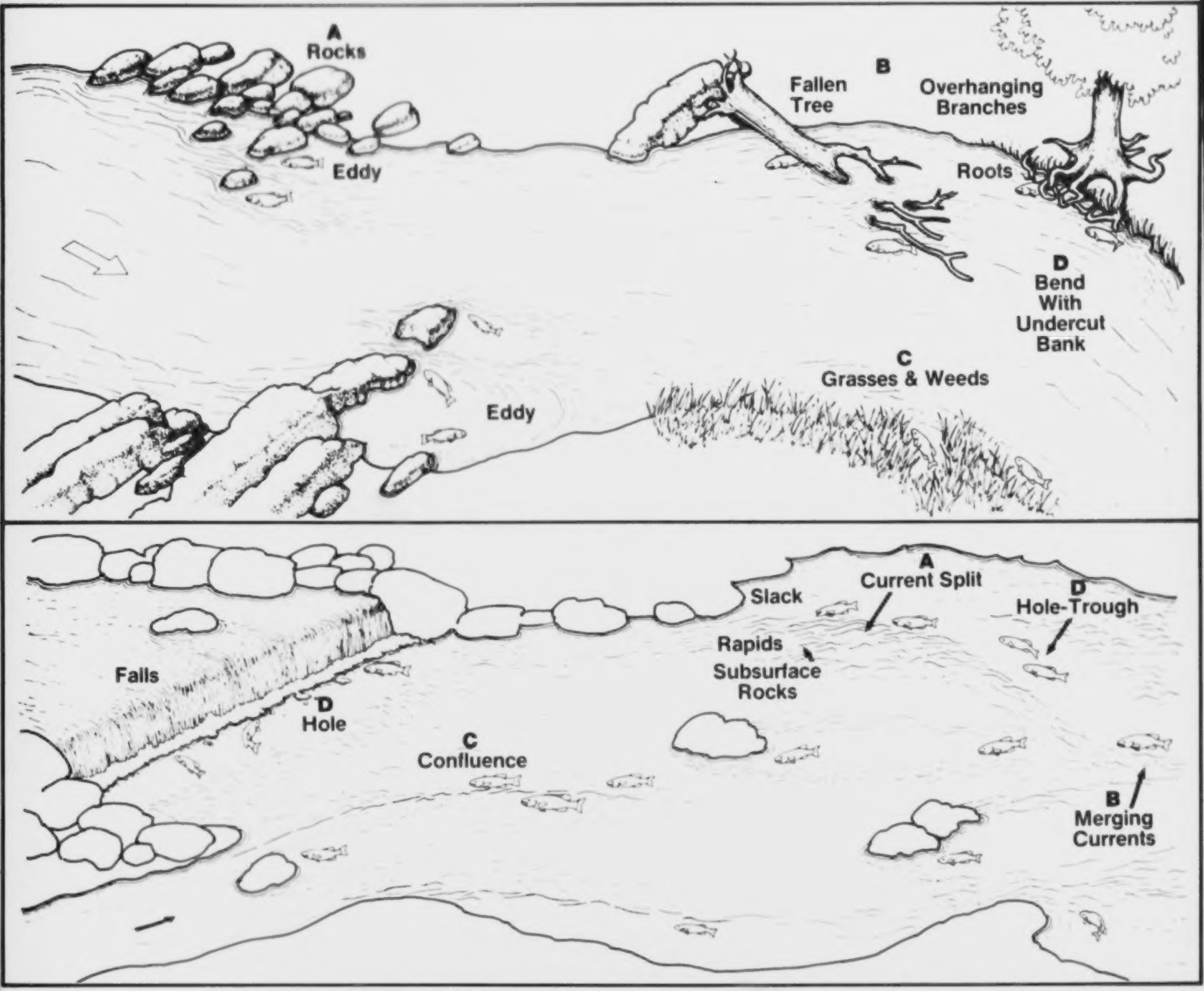
River and Stream Fishing

APC.38


Retrieve Across
Criss/Cross Currents
Drift With Or Without Action
Slack
Fast
Upstream Retrieve
Fast
Slack
Downstream Retrieve
Work Up and Down Currents

Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

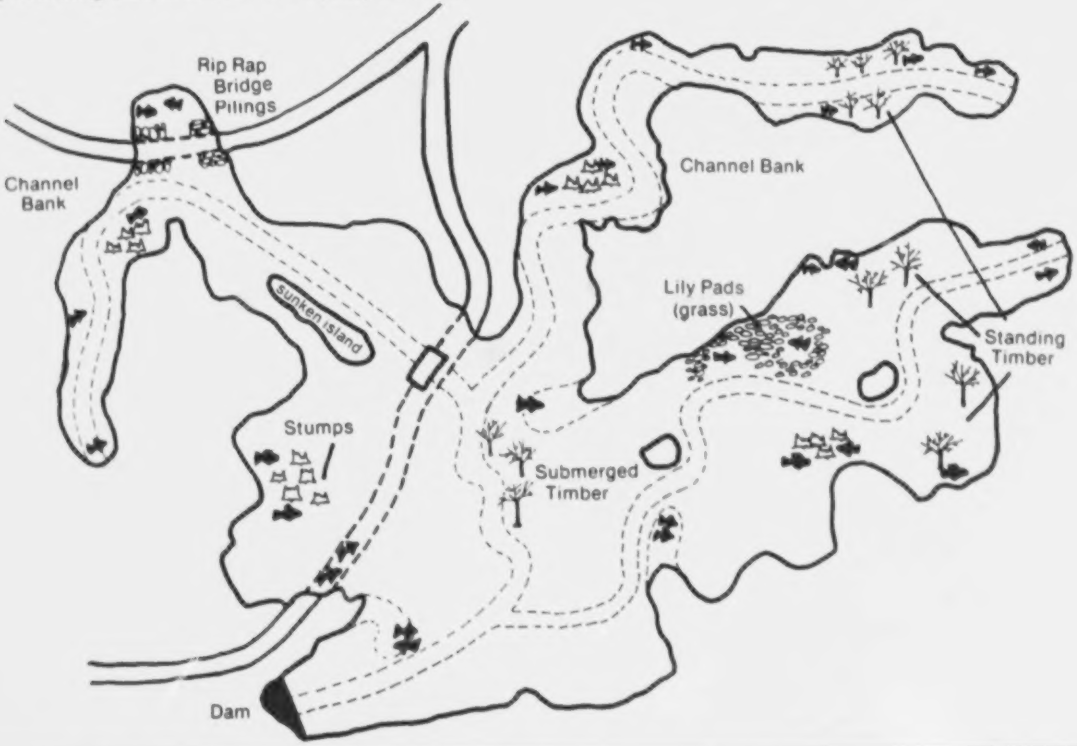
Locating Fish in Rivers and Streams


A
Rocks
Eddy
Fallen Tree
B
Overhanging Branches
Roots
D
Bend With Undercut Bank
C
Grasses & Weeds
Eddy
Slack
A
Current Split
D
Hole-Trough
Rapids
Subsurface Rocks
Falls
D
Hole
C
Confluence
B
Merging Currents

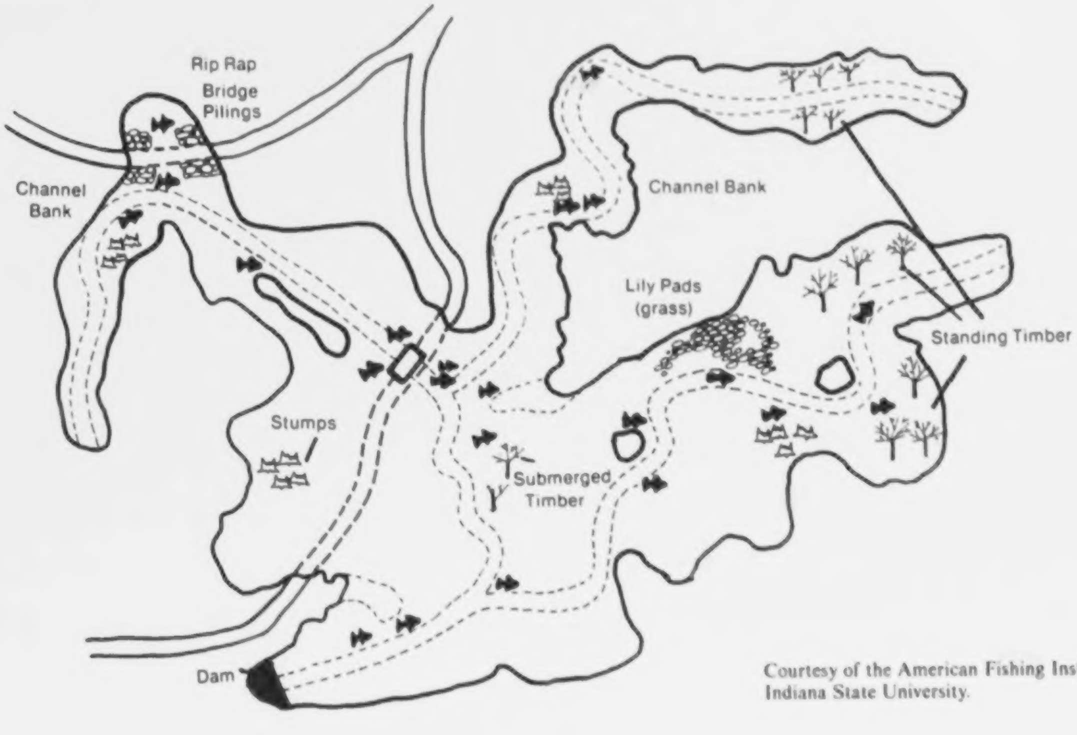
Courtesy of FIM Publishing, Phoenix, MD.
"Pocket Guide to Fishing" series.

Seasonal Fish Locations

Map showing locations of fish in spring season.


Rip Rap
Bridge
Pilings
Channel
Bank
Sunken Island
Stumps
Channel Bank
Lily Pads
(grass)
Standing
Timber
Submerged
Timber
Dam

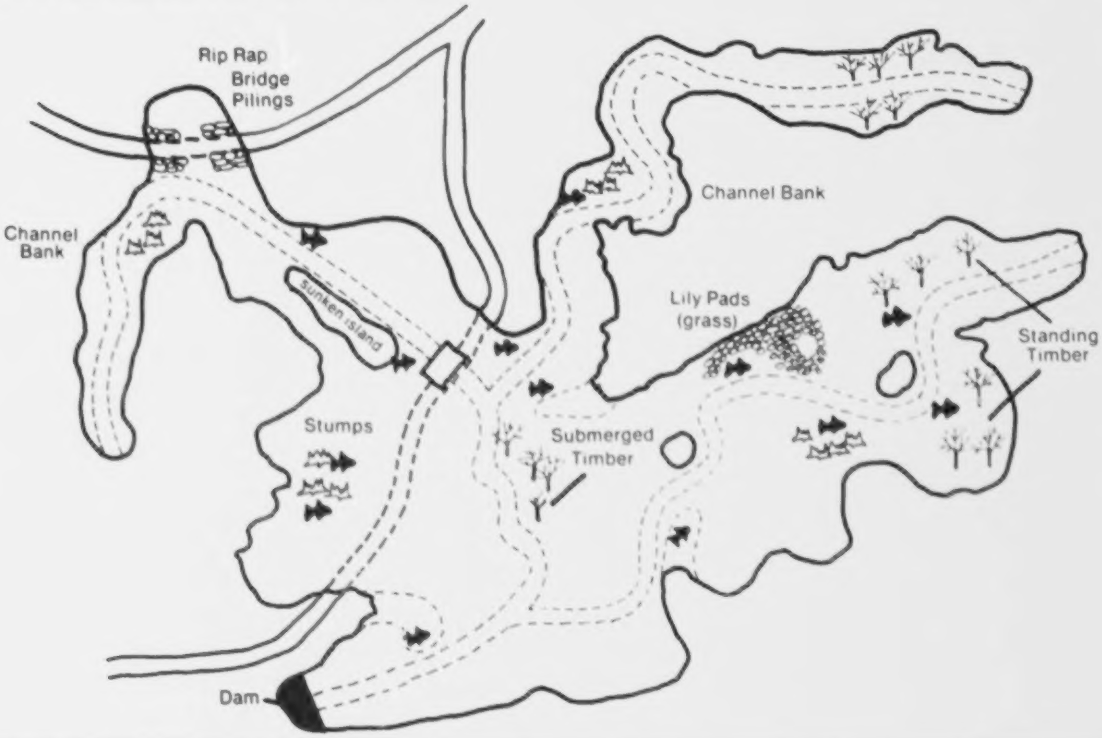
Map showing locations of fish in summer season.


Rip Rap
Bridge
Pilings
Channel
Bank
Stumps
Channel Bank
Lily Pads
(grass)
Standing Timber
Submerged
Timber
Dam

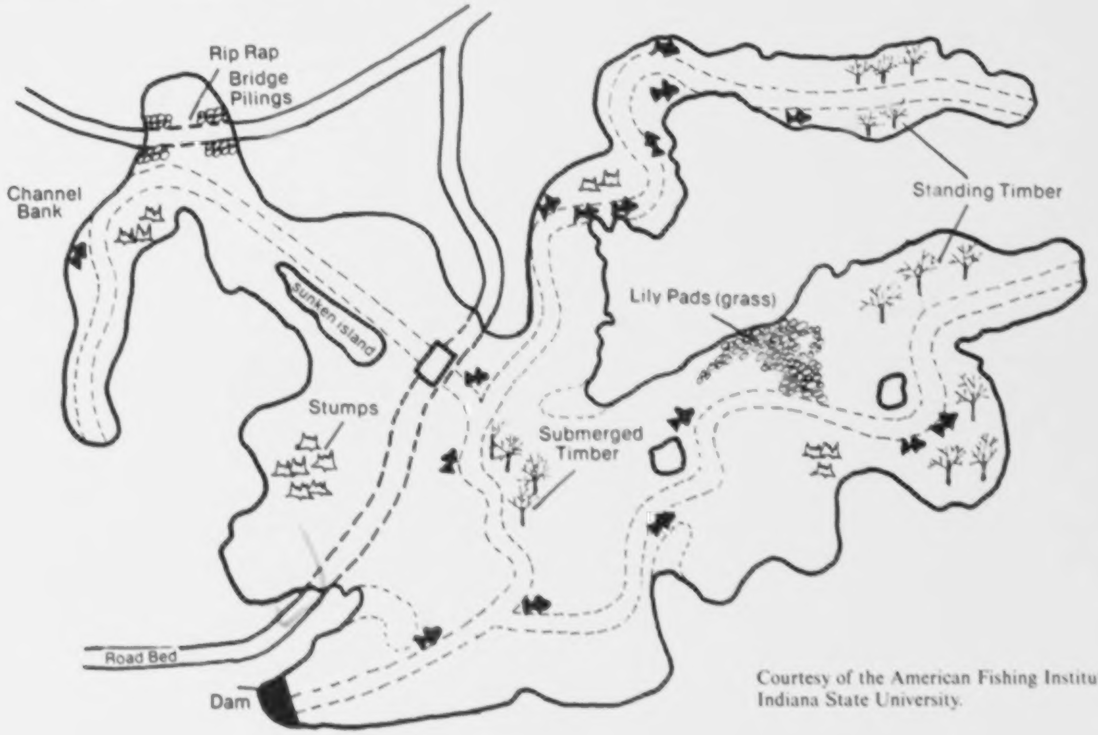
Courtesy of the American Fishing Institute,
Indiana State University.

Seasonal Fish Locations

Map showing locations of fish in fall season.

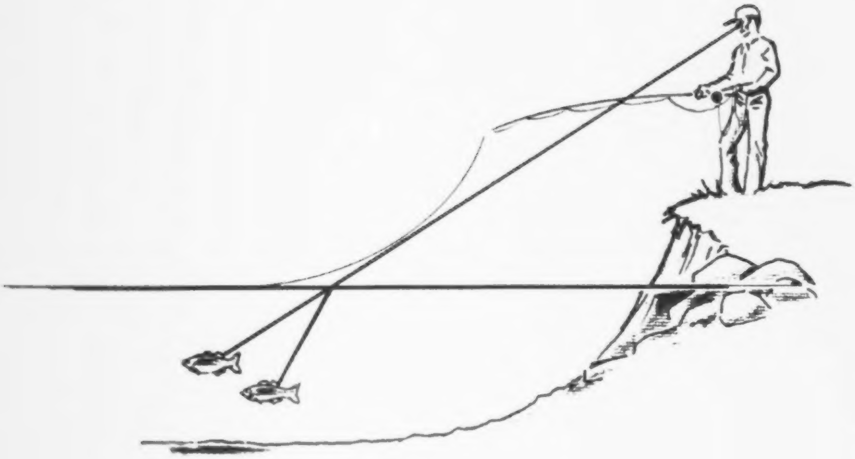

Rip Rap
Bridge Pilings
Channel Bank
Channel Bank
Sunken Island
Lily Pads (grass)
Standing Timber
Stumps
Submerged Timber
Dam

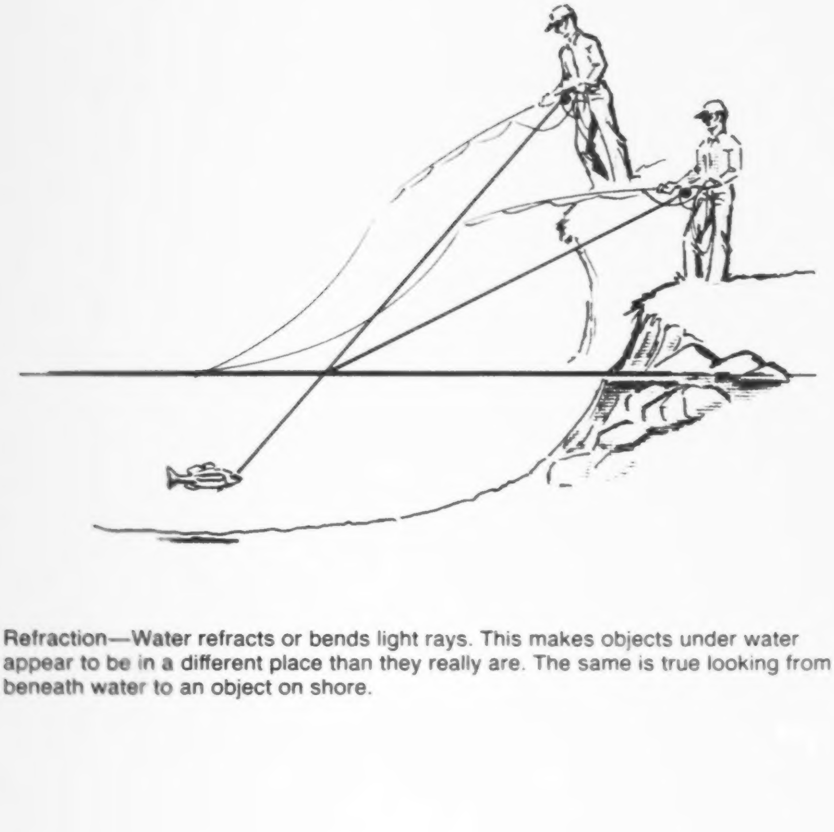
Map showing locations of fish in winter season.


Rip Rap
Bridge Pilings
Channel Bank
Standing Timber
Sunken Island
Lily Pads (grass)
Stumps
Submerged Timber
Road Bed
Dam

Courtesy of the American Fishing Institute, Indiana State University.

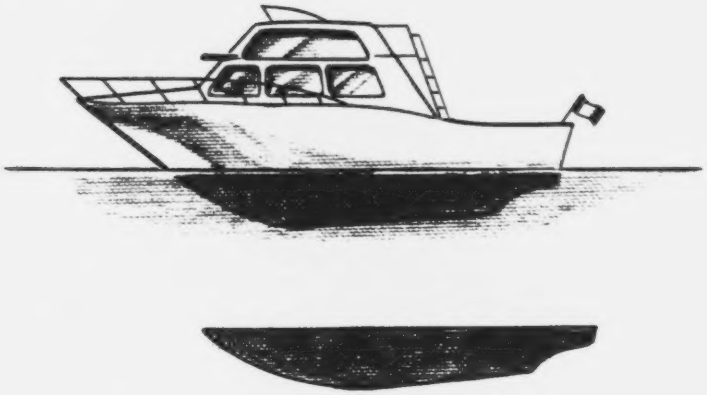
Refraction



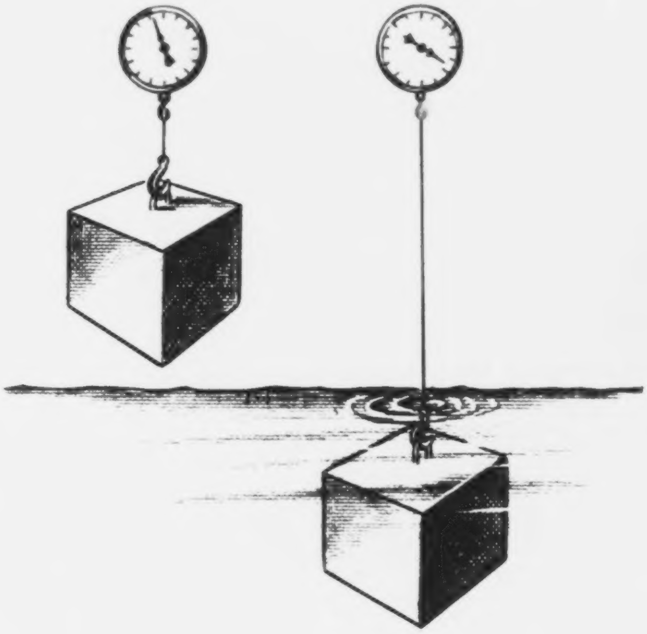


Refraction—Water refracts or bends light rays. This makes objects under water appear to be in a different place than they really are. The same is true looking from beneath water to an object on shore.

Bouyancy

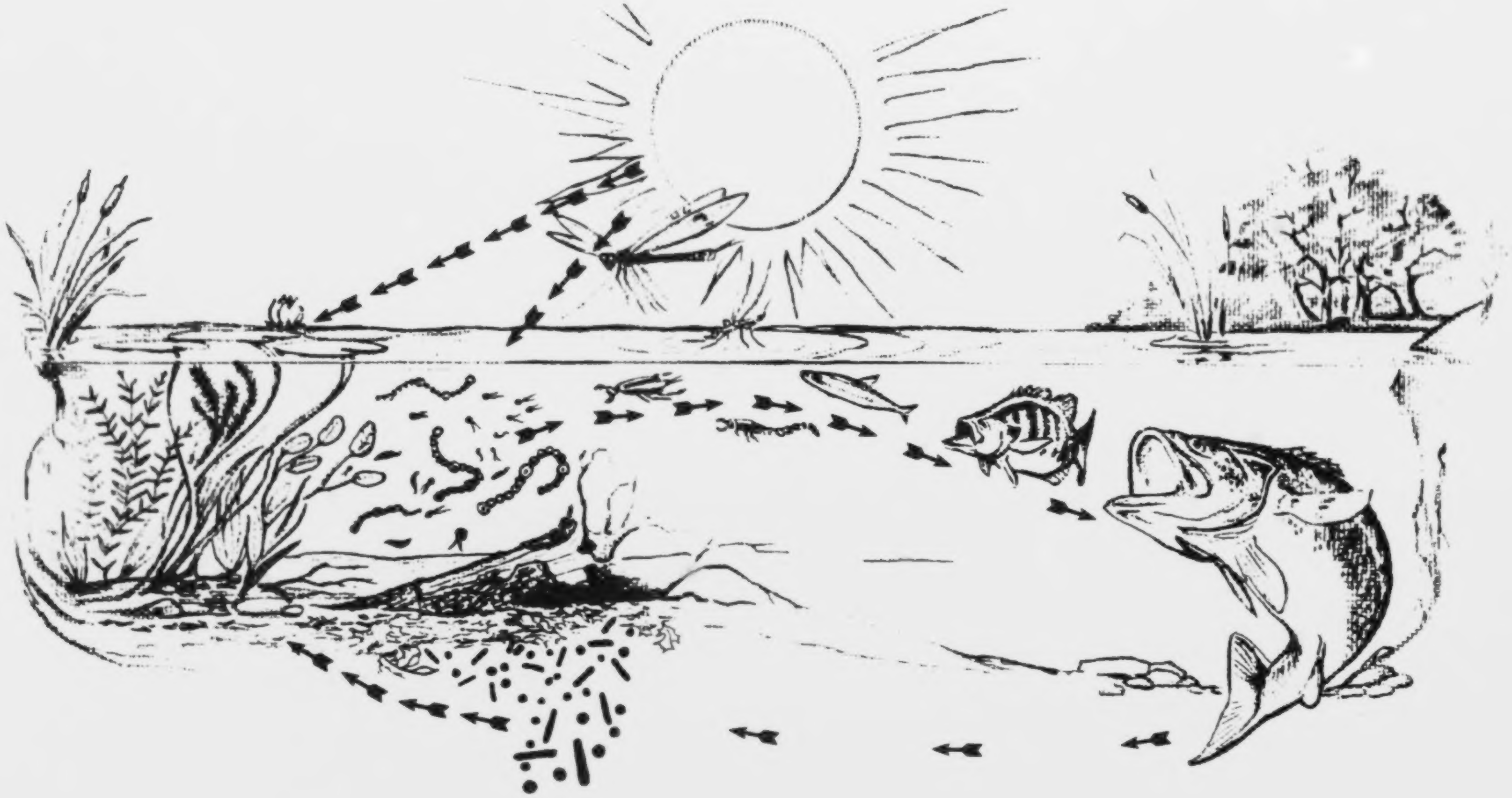


This boat is able to float because the hull, the shaded area, displaces an amount of water which weighs more than the boat and its contents.



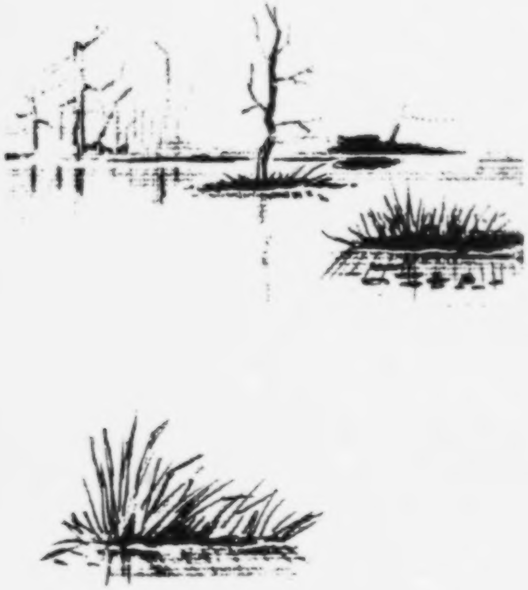
Articles appear to be lighter than they really are when they are in water. This block displaces an amount of water and the block's weight is reduced by the weight of water that it displaces.

The Food Chain

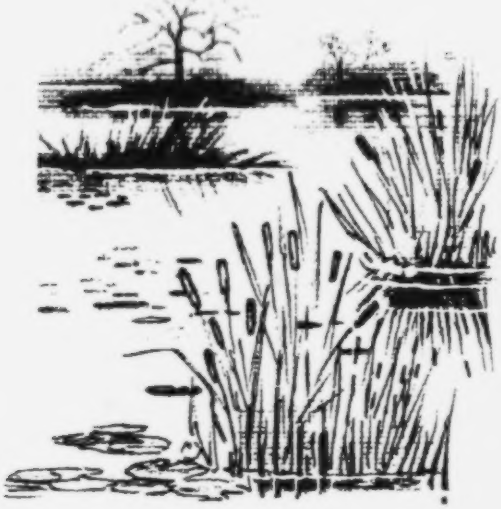


APC.44

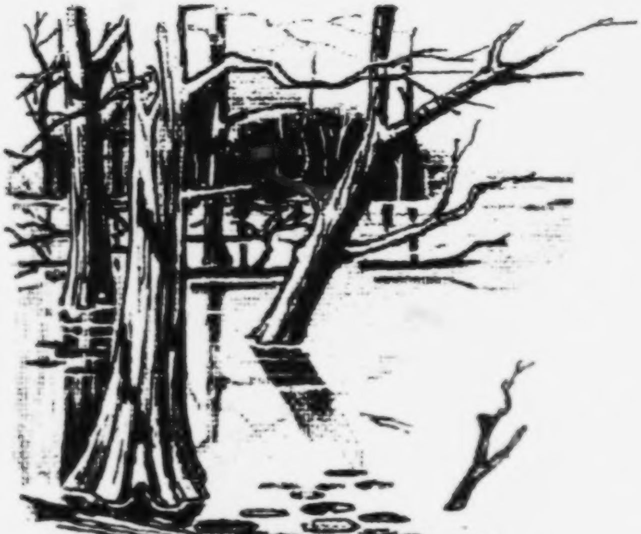
Aquatic Habitats



Wetlands

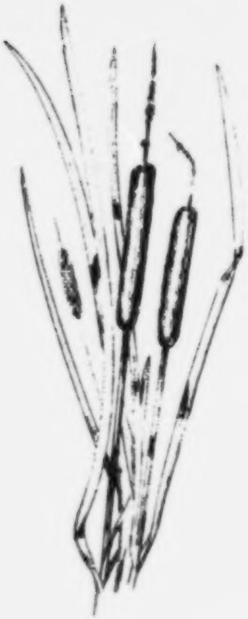


Marsh

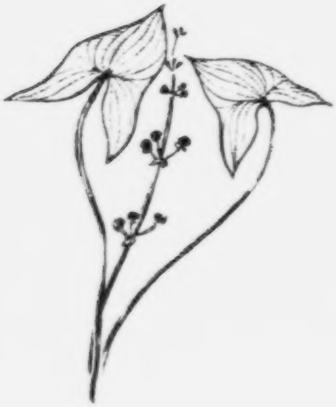


Swamp

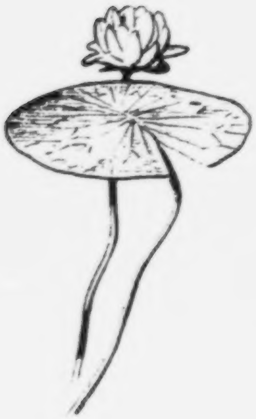
Common Aquatic Growth



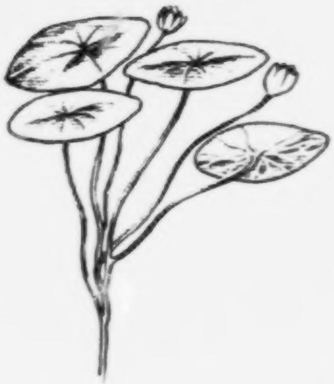
Cattail



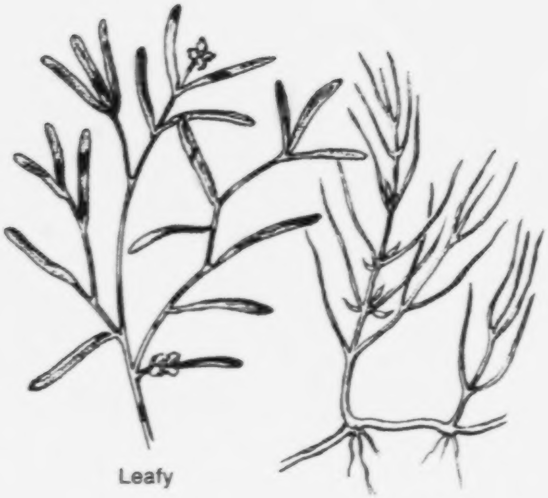
Arrowhead



Water Lily



Watershield

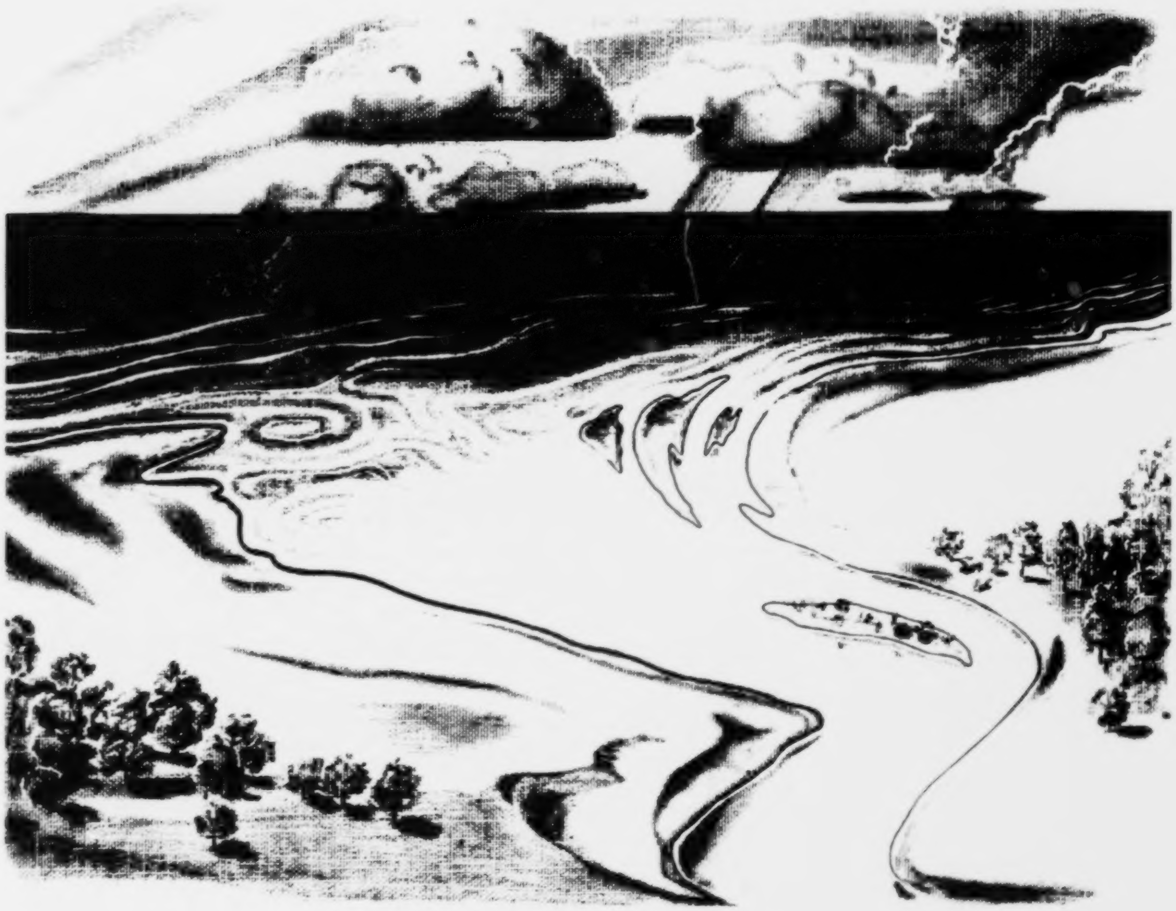


Leafy

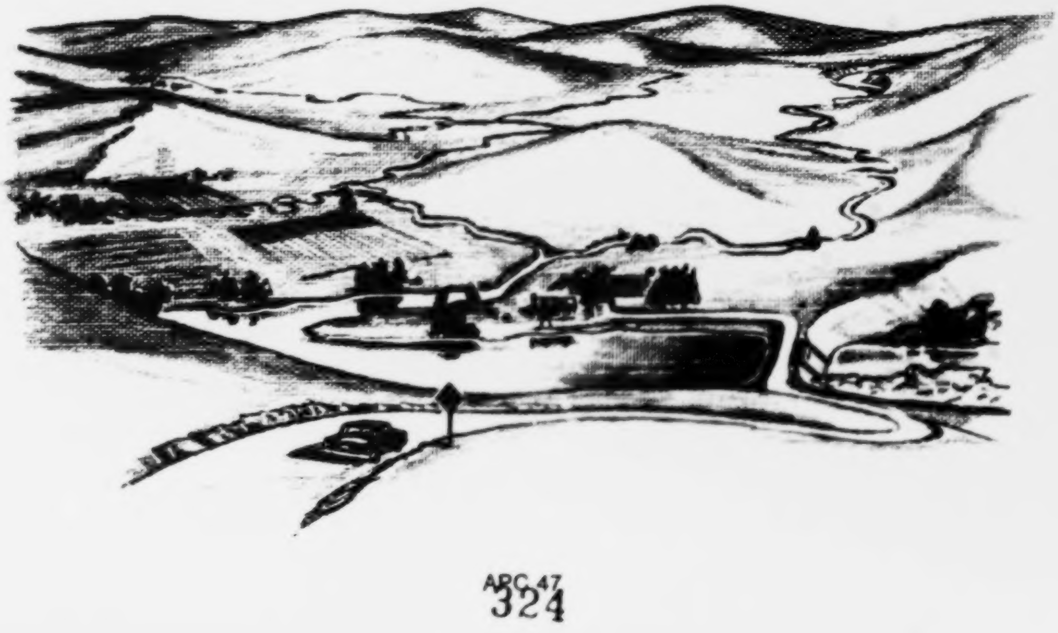
Horned

Pondweed

Estuary

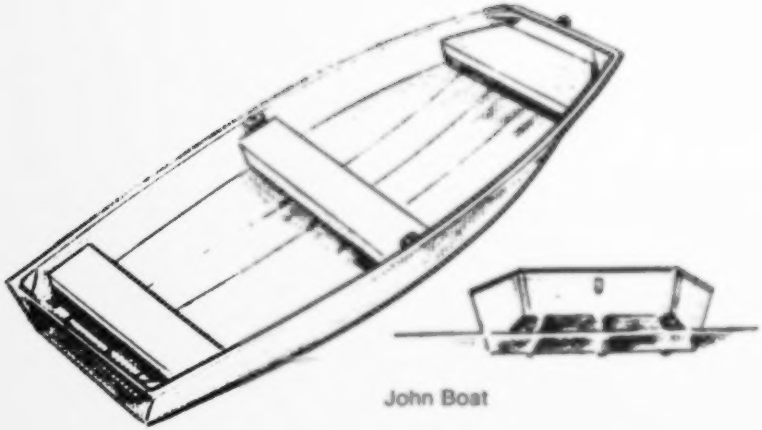


Watershed

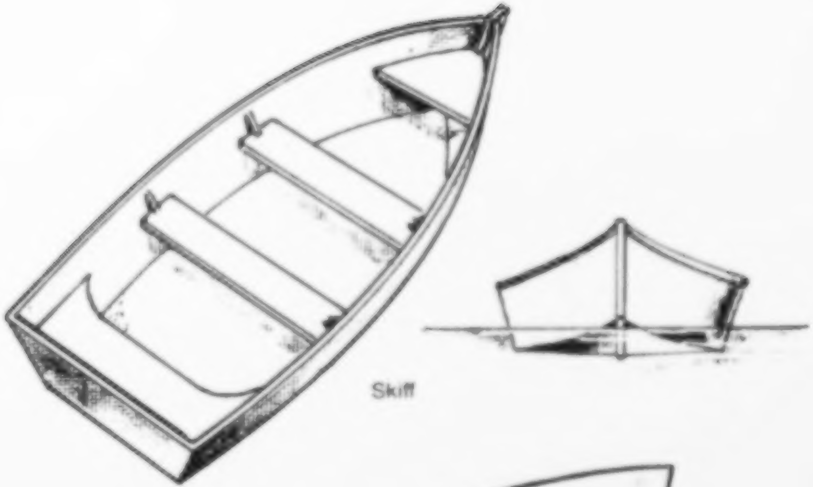


Common Boats

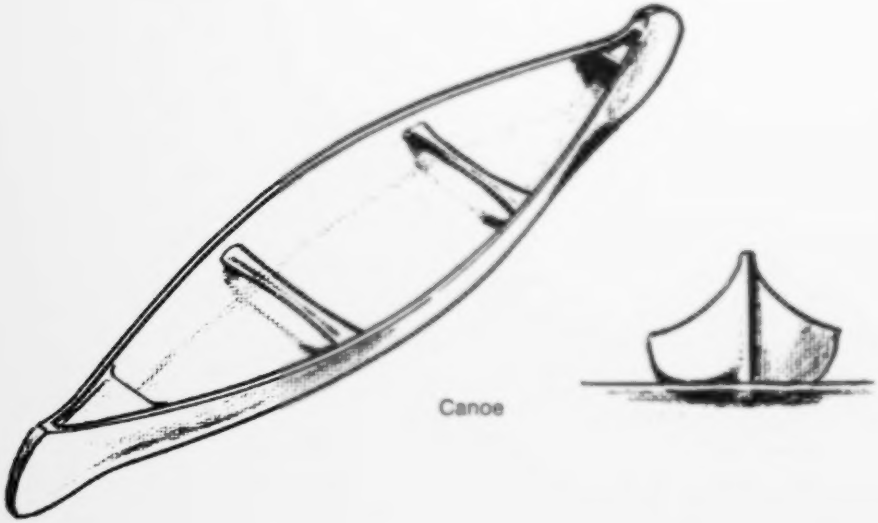
APC.48



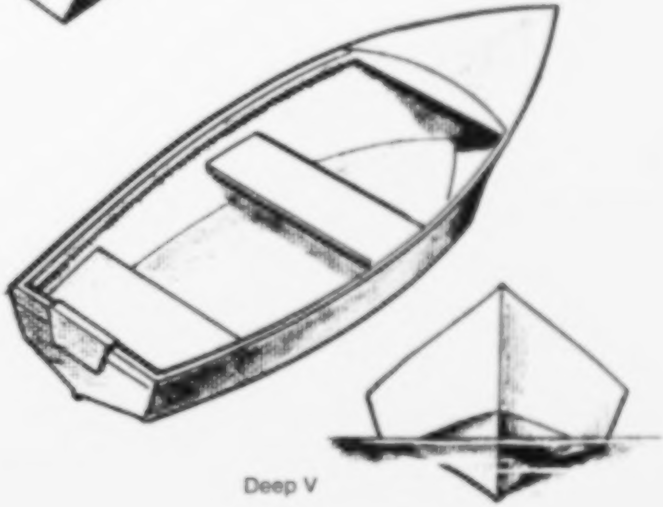
John Boat



Skiff

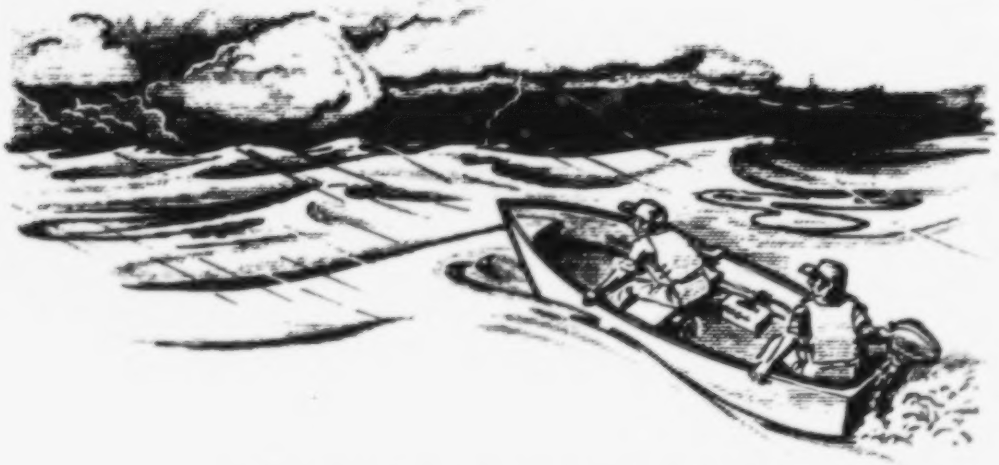


Canoe



Deep V

Safe Boating



If you do get into trouble, such as being caught in foul weather do the following things:

- Reduce speed.
- Head into waves at slight angle.
- Seat passengers on bottom of boat near center line and have them put on personal flotation devices.
- Make for nearest shelter or harbor.
- If motor fails, trail a sea anchor (or bucket or shirt with neck and sleeves knotted) from bow.
- If swamped or capsized, put on a personal flotation device and stay with boat.

CHECK LIST

- Personal Flotation Device (one United States Coast Guard approved of suitable size for each person, plus a throwable device on boats over 16 feet)
- Fire extinguisher
- Whistle or horn—to cover 1/2 mile or more depending on class of boat
- Bilge pump
- Extra line for towing
- Paddle or oars
- First aid kit
- Emergency signal kit
- Flashlight
- Basic tool kit

Now you have a safe boat. The next step is safe handling.

- Boarding—Never jump into the boat; step into center.
- Loading—Do not overload boat; distribute load evenly.
- Getting under way—start slowly, watch out for other boats, and keep passengers near center of boat.
- On the water—be alert! Keep a good lookout for bad weather, boats, swimmers, obstructions, fishermen, skiers, and skin and scuba divers and their flags.

Remember, these five things cause accidents:

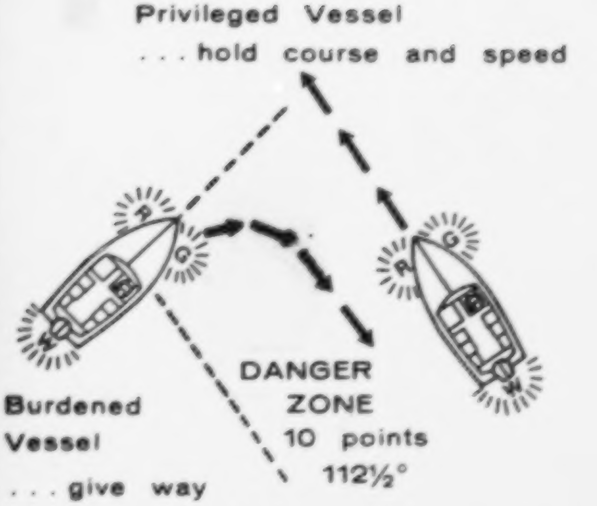
- Improper loading or overloading
- Disregard for weather conditions
- Improper lookout--be alert
- Falling overboard
- Unsafe fueling practice

- Calls for help:
  - a. Rapid blow of whistle or horn (toot-toot-toot-toot)
  - b. White shirt on pole or life preserver
  - c. Raise and lower arms slowly
  - d. Radio signal May Day or SOS
  - e. At night—red flares or sound horn or whistle

Courtesy of the American Fishing Institute,
Indiana State University.

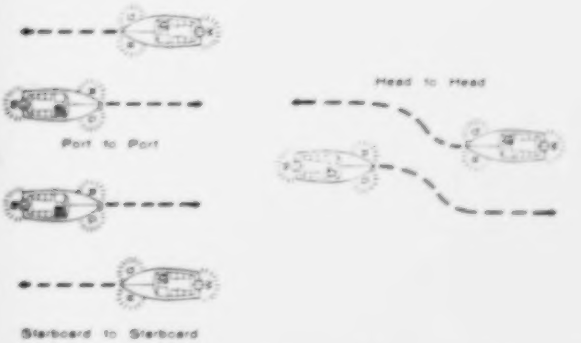
Rules of the "Road"

Crossing situation.


Privileged Vessel
. . . hold course and speed
R
G
W
DANGER ZONE
10 points
112½°
Burdened Vessel
. . . give way

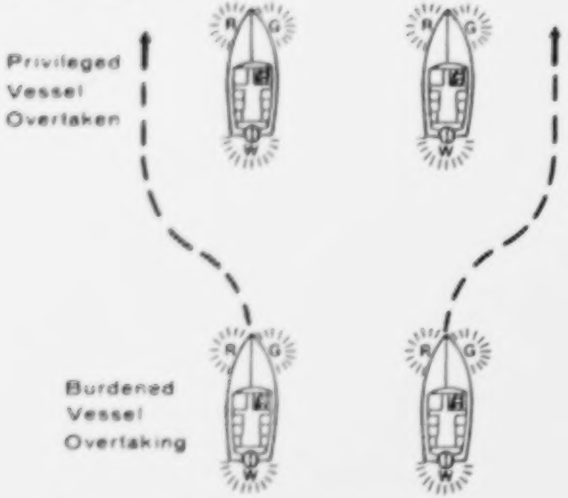
The boat to starboard has the right-of-way. It must hold course and speed. The burdened boat keeps clear and passes astern of the privileged boat.

Meeting situation.


Head to Head
Port to Port
Starboard to Starboard

Both boats turn to starboard and pass port to port.

Overtaking situation.


Privileged Vessel Overtaken
R
G
W
Burdened Vessel Overtaking

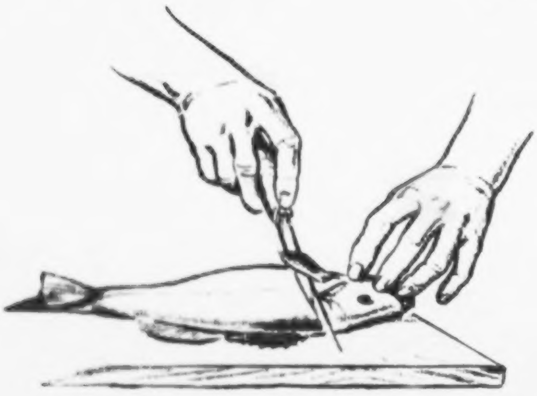
A sailboat usually has right-of-way over motorboats except when the sailboat is the overtaking boat or when it is under power. Sailboats are then considered motorboats under the rules of the road.

Boats propelled by oars or paddles have the right-of-way over motorboats. Small pleasure craft must yield to large commercial vessels in narrow channels. Large craft cannot move as easily as small boats.

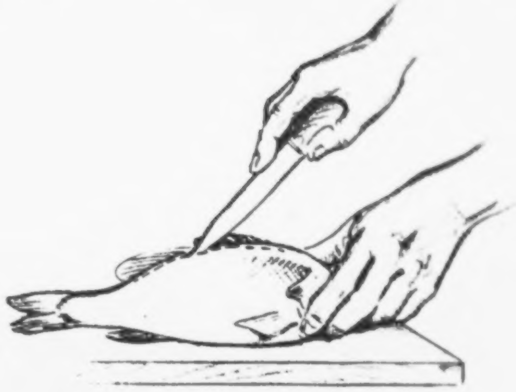
If it appears a collision is unavoidable if both craft continue on course, neither shall have the right-of-way. Under the General Prudential Rule, both boats must take action to avoid collision.

Courtesy of the American Fishing Institute,
Indiana State University.

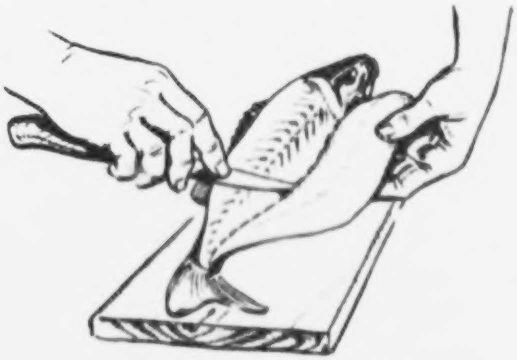
Filleting Fish



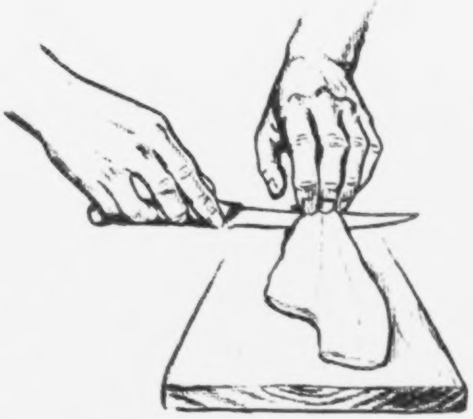
1 Make initial cut behind pectoral fin from backbone to stomach. Be careful not to puncture internal organs or sever the backbone.



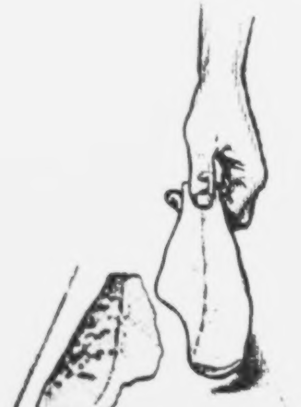
2 Cut all along the backbone down to rib cage.



3 Continue cutting down and over the rib cage until entire fillet is free of fish.

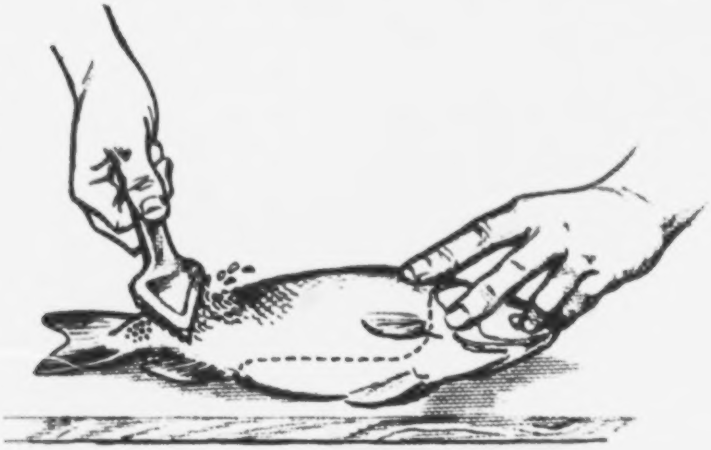


4 Take fillet and place skin down on fillet board. Insert knife between flesh and skin. Holding knife at an angle and using a sawing motion, remove fillet from skin.



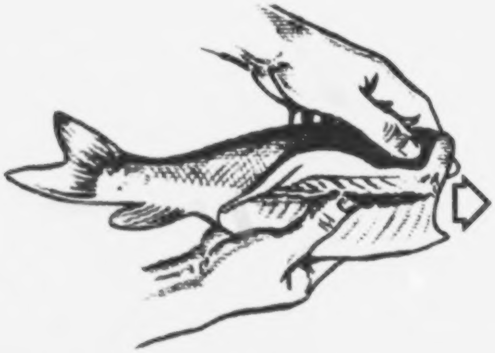
5 Place fillet in clean water. Turn fish over and repeat process.

Cleaning Fish

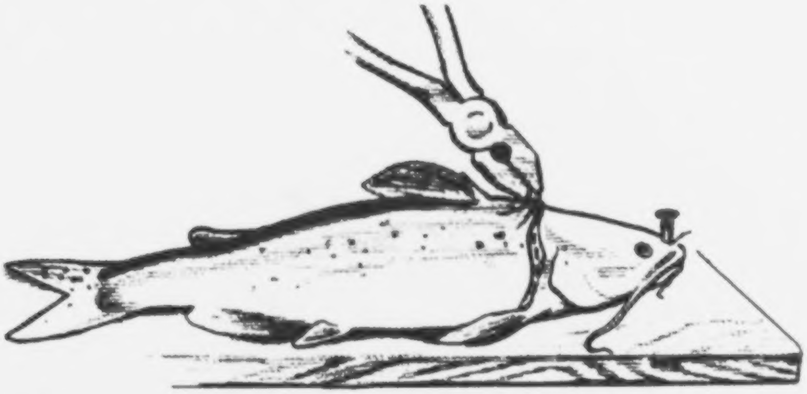


Scaling

1. Use scaler from tail toward head to remove all scales.



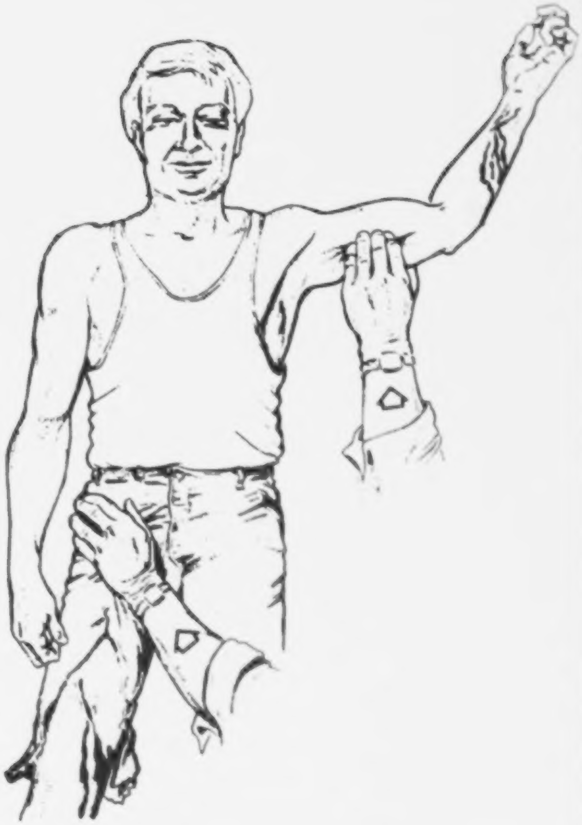
2. Remove entrails and cut off head. Remove blood vein located near backbone. Cut off caudal fin (tail) and other fins. Wash and cook whole.



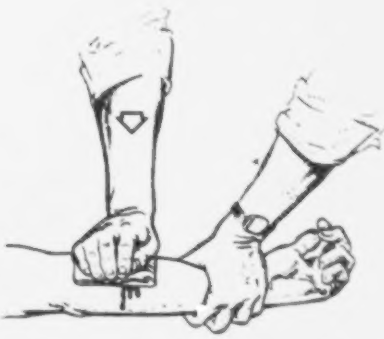
Skinning

Make cut behind head and pectoral fin around fish. Use pliers to pull skin from head toward tail. Proceed with Step 2 above to finish cleaning.

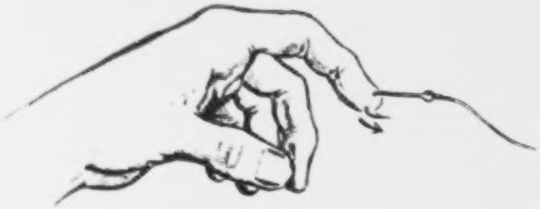
Emergency Procedures



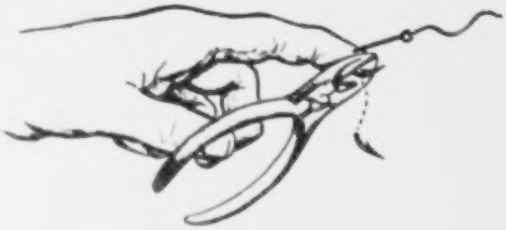
Stop bleeding by putting pressure on major arteries for extremities.



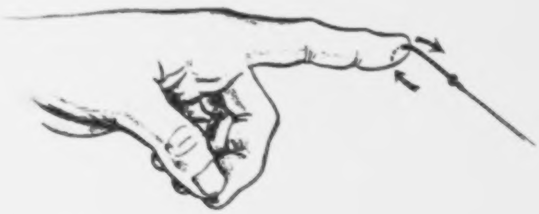
Direct pressure on wound will stop bleeding of minor cuts.



If hook barb penetrates through skin (in many cases it will be necessary to push the barb through the skin)

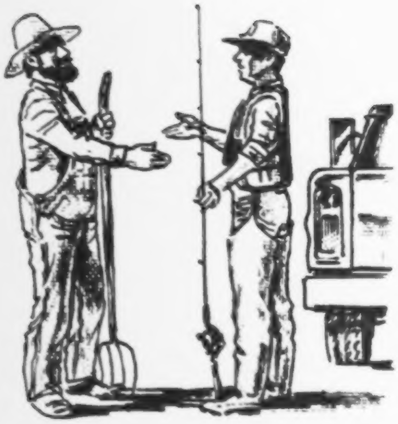


Trim barb with wire cutters.

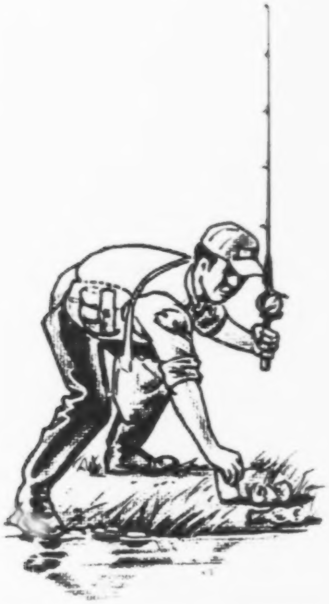


Back hook out of finger.

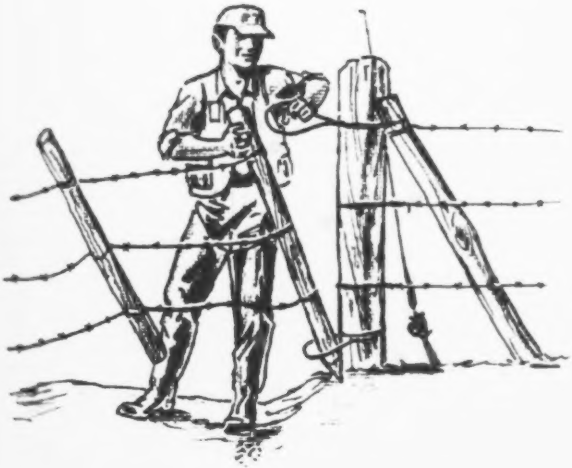
Ethics in the Field



Ask permission before entering another person's property.



Pick up litter, yours or that left by others.



Close gates to keep animals where they are supposed to be.

This is to certify that

____

has successfully completed the

AQUATIC
RESOURCES
EDUCATIONAL
CURRICULUM

____
INSTRUCTOR

____
DATE